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# UNITED STATES AIR FORCE
# ELMENDORF AIR FORCE BASE, ALASKA

*ENVIRONMENTAL RESTORATION PROGRAM*

## OPERABLE UNIT 6 AND SOURCE AREA SS19
## RECORD OF DECISION

FINAL

JANUARY 1997

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## ACRONYM LIST

| | | |
|---|---|---|
| AAC | = | Alaska Administrative Code |
| ACM | = | Alaska Cleanup Matrix for non-UST Soils. |
| ADEC | = | Alaska Department of Environmental Conservation |
| AFB | = | Air Force Base |
| ARARs | = | Applicable or Relevant and Appropriate Requirements |
| AS | = | Alaska Statute |
| BESG | = | Elmendorf Bioenvironmental Engineering Services Group |
| bgs | = | Below Ground Surface |
| CERCLA | = | Comprehensive Environmental Response, Compensation, and Liability Act of 1980 |
| CFR | = | Code of Federal Regulations |
| cm/sec | = | Centimeters Per Second |
| COC | = | Contaminant of Concern |
| COE | = | Corps of Engineers |
| CSF | = | Cancer Slope Factor |
| DCA | = | Dichloroethane |
| DCE | = | Dichloroethene |
| DRMO | = | Defense Reutilization and Marketing Office |
| ELCR | = | Excess Lifetime Cancer Risks |
| ERA | = | Ecological Risk Assessment |
| EQ | = | Ecological Quotients |
| FFA | = | Federal Facilities Agreement |
| FAA | = | Federal Aviation Administration |
| FS | = | Feasibility Study |
| ft/day | = | Feet Per Day |
| HEAST | = | Health Effects Assessment Summary Table |
| HI | = | Hazard Index |
| HRA | = | Health Risk Assessment |
| HVOC | = | Halogenated Volatile Organic Compound |
| ICIR | = | Institutional Controls with Intrinsic Remediation |
| IRIS | = | Integrated Risk Information System |
| IRP | = | Installation Restoration Program |
| LFI | = | Limited Field Investigation |
| MCL | = | Maximum Contaminant Level |
| mg/kg | = | Milligrams Per Kilogram |
| msl | = | Mean Sea Level |
| NCP | = | National Oil and Hazardous Substances Pollution Contingency Plan |
| NFA | = | No Further Action |
| NOAA | = | National Oceanographic and Atmospheric Administration |
| O&M | = | Operation and Maintenance |
| OU | = | Operable Unit |
| PCA | = | Tetrachloroethane |
| PCBs | = | Polychlorinated Biphenyls |
| POL | = | Petroleum Oils and Lubricants |
| ppmv | = | Parts Per Million by Volume |
| PVC | = | Polyvinyl Chloride |
| RAO | = | Remedial Action Objective |

## ACRONYMS (CONTINUED)

| | | |
|---|---|---|
| RCRA | = | Resource Conservation and Recovery Act |
| RfD | = | Reference Dose |
| RI | = | Remedial Investigation |
| RI/FS | = | Remedial Investigation/Feasibility Study |
| RME | = | Reasonable Maximum Exposure |
| ROD | = | Record of Decision |
| SARA | = | Superfund Amendments and Reauthorization Act |
| SERA | = | State-Elmendorf Environmental Restoration Agreement |
| SVOC | = | Semi-Volatile Organic Compound |
| TBC | = | To-Be-Considered |
| TCA | = | 1,1,1-Trichloroethane |
| TCE | = | Trichloroethene |
| UCL | = | Upper Confidence Limit |
| UDRO | = | Unidentified Diesel Range Organics |
| $\mu$g/L | = | Micrograms Per Liter |
| UGRO | = | Unidentified Gasoline Range Organics |
| USAF | = | United States Air Force |
| USC | = | United States Code |
| USEPA | = | United States Environmental Protection Agency |
| USGS | = | United States Geological Survey |
| UST | = | Underground Storage Tank |
| VOC | = | Volatile Organic Compound |

PART I

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## PART I. DECLARATION

### SITE NAME AND LOCATION

Elmendorf Air Force Base (AFB)
Operable Unit (OU) 6
Elmendorf Air Force Base, Alaska

### STATEMENT OF BASIS AND PURPOSE

This Record of Decision (ROD) presents the selected remedial action for OU 6 at Elmendorf AFB. It was developed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), 42 U.S. Code (USC) § 9601 et seq., and to the extent practicable, in accordance with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 Code of Federal Regulations (CFR) § 300 et seq. The attached administrative record index (Appendix A) identifies the documents upon which the selection of the remedial action was based.

OU 6 is the last operable unit to be investigated at Elmendorf AFB, and as such is comprised of a mixed assemblage of source areas. It is composed of three former landfills (LF02, LF03, and LF04), two sludge disposal pits (SD15 and WP14), and a surface disposal area around a rock testing laboratory (SD73). The ROD also addresses an additional source area, a former storage bunker designated SS19.

### ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances including fuels, fuel constituents, and halogenated volatile organic compounds from this OU, if not addressed by implementing the response action selected in this ROD, could present an imminent or substantial endangerment to public health, welfare, or the environment. Specific hazardous substances include constituents such as benzene, toluene, trichloroethene, and tetrachloroethane.

### DESCRIPTION OF THE SELECTED REMEDIES

The selected remedies were chosen from many alternatives as the best methods of addressing contaminated groundwater and soil within the various source areas in OU 6. The selected remedies address the associated risks by a combination of actions to reduce contamination below cleanup levels for OU 6 established in this ROD and institutional controls to prevent exposure to contamination above those cleanup levels. This is the last operable unit to be investigated at Elmendorf AFB and is intended to be the final ROD for this base.

The U.S. Air Force (USAF), the U.S. Environmental Protection Agency (USEPA), and the State of Alaska, through the Department of Environmental Conservation (ADEC), concur with the selected remedies. The major components of the selected remedies which address the principle threats posed by the conditions within the OU 6 source areas include:

**Source Area WP14:**

Groundwater at WP14:

- Institutional controls on land use and water use, as specified in the Base Comprehensive Plan, will restrict access to the contaminated groundwater throughout WP14. Installation of wells in the contaminated plume for residential, industrial, and agricultural use will be prohibited by the Base Comprehensive Plan until cleanup levels have been achieved.

- Groundwater will be monitored semi-annually and evaluated annually to determine contaminant migration and to track the progress of contaminant degradation and dispersion, as well as to provide an early indication of unforseen environmental or human health risk. Five-year reviews will also assess the protectiveness of the remedial action, including an evaluation of any changed site conditions, as long as contamination remains above cleanup levels.

- Recoverable quantities of free product found on top of the water table at WP14 will be regularly removed during groundwater monitoring events.

- Groundwater monitoring will be discontinued if contaminant levels are below cleanup levels during two consecutive monitoring events. In that case, no further action for groundwater will be required.

- During the final round of monitoring, samples will be collected and analyzed for all constituents that exceeded maximum contaminant levels (MCLs) during the 1994 investigation including volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and metals. These results will be evaluated before a final determination is made that groundwater meets all cleanup requirements.

- All groundwater is expected to be cleaned up within 14 years.

Soil at WP14:

- No further action will be required for the soil at WP14.

**Source Area LF04:**

Groundwater at LF04 North/Beach:

- No further action is required for the groundwater at LF04 North/Beach.

Groundwater at LF04 South:

- Access to groundwater at LF04 South will be institutionally controlled. LF04 is currently designated as a "restricted use area" in the Base Comprehensive Plan. This designation provides for recreational use of the parcel (cross country skiing, etc.) and for construction of unmanned facilities such as a parking lot, storage building, or taxiway, but prohibits the construction of any sort of manned facility such as an office building or a residence. Drilling into the shallow aquifer is also restricted by the Base Comprehensive Plan. As a former landfill, LF04 will maintain this designation indefinitely.

- Groundwater will be monitored and evaluated annually to determine contaminant migration and to track the progress of contaminant degradation and dispersion, as well as to provide an early indication of unforseen environmental or human health risk. Five-year reviews will also assess the protectiveness of the remedial action, including an evaluation of any changed site conditions, as long as contamination remains above cleanup levels.

- Recoverable quantities of free product found on top of the water table at LF04 will be regularly removed during groundwater monitoring events.

- Groundwater monitoring will be discontinued if contaminant levels are below cleanup levels during two consecutive monitoring events. In that case, no further action for groundwater will be required.

- During the final round of monitoring, samples will be collected and analyzed for all constituents that exceeded MCLs during the 1994 investigation including VOCs, SVOCs, and metals. These results will be evaluated before a final determination is made that groundwater meets all cleanup requirements.

- All groundwater is expected to be cleaned up within 14 years.

Soil at LF04 North/Beach:

- Access to soil at LF04 North/Beach will be institutionally controlled. LF04 is currently designated as a "restricted use area" in the Base Comprehensive Plan. This designation provides for recreational use of the parcel (cross country skiing, etc.) and for construction of unmanned facilities such as a parking lot, storage building, or taxiway, but prohibits the construction of any sort of manned facility such as an office building or a residence. As a former landfill, LF04 will maintain this designation indefinitely.

- No further action is required for soil contamination at LF04 North/Beach; however, landfill debris on the beach from LF04 will be removed annually as the specific remedy for this area.

- The removal of debris will include all LF04 landfill material which has fallen onto the beach which can be reasonably collected for disposal, as well as debris on the bluff slope or other low lying areas which can be accessed and removed without hazard.

- Hazardous materials encountered during the annual removal events will be handled according to appropriate regulations.

- The removal of debris from the beach at LF04 is expected to continue annually for 30 years or as long as the landfill remains subject to erosional action by tides. Five-year reviews will assess the protectiveness of the remedial action, including an evaluation of any changed site conditions.

- No further action will be required as a means of closing the LF04 landfill.

Soil at LF04 South:

- No further action is required for the soil at LF04 South.

**Source Area SD15:**

Perched Aquifer Groundwater at SD15:

- Institutional controls on land use and water use, as specified in the Base Comprehensive Plan, will restrict access to the contaminated groundwater throughout SD15. Installation of wells in the contaminated plume for residential, industrial, or agricultural use will be prohibited by the Base Comprehensive Plan until cleanup levels have been achieved.

- Groundwater in the perched aquifer at SD15 will be treated by a high-vacuum extraction process to remove fuel related contaminants and halogenated volatile organic compounds (HVOCs).

- Recoverable quantities of free product found on top of the water table at SD15 will be removed through the high-vacuum extraction process.

- Treated water will be reinjected into the subsurface beyond the boundary of the contaminated aquifer. Reinjected water will be regularly monitored to ensure it meets cleanup and risk requirements.

- Groundwater remaining above cleanup levels will continue to be monitored semi-annually and evaluated annually to determine contaminant migration and to track the progress of the high-vacuum extraction treatment, as well as to provide an early indication of unforseen environmental or human health risk. Five-year reviews will also assess the protectiveness of the remedial action, including an evaluation of any changed site conditions, as long as contamination remains above cleanup levels.

- When two consecutive groundwater monitoring events indicate contaminant concentrations are below cleanup levels, the high-vacuum extraction system will be shut-off. Semi-annual monitoring will continue for another year, and subsurface soil samples will be collected. If levels are confirmed to be below cleanup levels one year after the system was shut-off, no further remedial action will be required. If contamination is present in any of the samples, the system will be restarted, or another remedial option will be considered.

- During the final round of groundwater monitoring, samples will be collected and analyzed for all constituents that exceeded MCLs during the 1994 investigation including VOCs and arsenic. These results will be evaluated before a final decision is made that groundwater meets all cleanup requirements.

- All groundwater is expected to be cleaned up within 5 years.

Deep Aquifer Groundwater at SD15:

- No further action is required for the deep aquifer groundwater at SD15.

Soil at SD15:

- Shallow soils (less than 5 feet deep) with contamination above cleanup levels will be excavated, removed, and thermally treated to eliminate fuel-related contaminants. After treatment, no further action will be required for the shallow soils.

- Deep soils at SD15 will be actively treated through air stripping associated with the high-vacuum extraction process described for the perched aquifer groundwater.

- Soils with contamination above cleanup levels will be sampled one year after system start up and every 3 years thereafter to evaluate contaminant migration and timely reduction of contaminant concentrations by high-vacuum extraction. If cleanup levels are not being achieved, further remedial action will be evaluated. This will include 5-year reviews to assess the protectiveness of the remedial action, including an evaluation of any changed site conditions, as long as contamination remains above cleanup levels.

- When two consecutive groundwater monitoring events indicate contaminant concentrations are below cleanup levels, the high-vacuum extraction system will be shut-off. Semi-annual monitoring will continue for another year, and subsurface soil samples will be collected. If levels are confirmed to be below cleanup levels one year after the system was shut-off, no further remedial action will be required. If contamination is present in any of the samples, the system will be restarted, or another remedial option will be considered.

- All soils are expected to be cleaned up within 5 years.

**Source Area LF02:**

Groundwater at LF02 (Including Seeps):

- Access to groundwater at LF02 will be institutionally controlled. LF02 is currently designated as a "restricted use area" in the Base Comprehensive Plan. This designation provides for recreational use of the parcel (cross country skiing, etc.) and for construction of unmanned facilities such as a parking lot, storage building, or taxiway, but prohibits the construction of any sort of manned facility such as an office building or a residence. Drilling into the shallow aquifer is also restricted by the Base Comprehensive Plan. As a former landfill, LF02 will maintain this designation indefinitely.

- Groundwater will be monitored semi-annually and evaluated annually to determine contaminant migration and to track the progress of contaminant degradation and dispersion, as well as to provide an early indication of unforseen environmental or human health risk. Five-year reviews will also assess the protectiveness of the remedial action, including an evaluation of any changed site conditions, as long as contamination remains above cleanup levels.

- Groundwater monitoring will be discontinued if contaminant levels are below cleanup levels during two consecutive monitoring events. In that case, no further action for groundwater will be required.

- During the last round of groundwater monitoring, samples will be collected and analyzed for all constituents that exceeded MCLs during the 1994 investigation, including VOCs and SVOCs. These results will be evaluated before a final determination is made that groundwater meets all cleanup requirements.

- All groundwater is expected to be cleaned up within 23 years.

Soil at LF02:

- Access to soil at LF02 will be institutionally controlled. LF02 is currently designated as a "restricted use area" in the Base Comprehensive Plan. This designation provides for recreational use of the parcel (cross country skiing, etc.) and for construction of unmanned facilities such as a parking lot, storage building, or taxiway, but prohibits the construction of any sort of manned facility such as an office building or a residence. As a former landfill, LF02 will maintain this designation indefinitely.

- A limited soil cover will be applied in three areas with elevated lead concentrations at LF02. This will eliminate the pathway for contact with the lead contamination. Five-year reviews will be conducted to evaluate the integrity of the cover, evaluate impacts from any changed site conditions, and assess the continued protectiveness of this remedial action.

- Landfill debris on top of or protruding from the ground surface at LF02 will also be removed as part of the specific remedy for this area.

- Hazardous materials encountered during the removal event will be handled according to appropriate regulations.

- No further action will be required as a means of closing the LF02 landfill.

**Source Area LF03:**

Groundwater at LF03:

- No further action is required for the groundwater at LF03.

Soil at LF03:

- No further action is required for the soil at LF03.

- No further action will be required as a means of closing the LF03 landfill.



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**Source Area SD73:**

Groundwater at SD73:

- No further action is required for the groundwater at SD73.

Soil at SD73:

- No further action is required for the soil at SD73.

No further action is required for soil or groundwater at Source Area SS19, which is also addressed in this Record of Decision.

**STATUTORY DETERMINATIONS**

The selected remedies are protective of human health and the environment, comply with federal and state requirements that are legally applicable or relevant and appropriate to the remedial action, and are cost-effective. These remedies utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable, and satisfy the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element for groundwater and soil.

The selected remedies will result in contaminants remaining on-site above health-based levels. A review will be conducted within 5 years after commencement of remedial action. The review will ensure that the remedies continue to provide adequate protection of human health and the environment.

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**LEAD AGENCY ACCEPTANCE**

**OF THE RECORD OF DECISION,**

**ELMENDORF AIR FORCE BASE, OPERABLE UNIT 6**

This signature sheet documents the U.S. Air Force acceptance of the Record of Decision for Operable Unit 6 at Elmendorf Air Force Base.

Eugene D. Santarelli

EUGENE D. SANTARELLI, Lt Gen, USAF
Chairman, HQ PACAF
Environmental Protection Committee

27 JAN 97
Date

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**LEAD AGENCY ACCEPTANCE**

**OF THE RECORD OF DECISION,**

**ELMENDORF AIR FORCE BASE, OPERABLE UNIT 6**

This signature sheet documents United States Environmental Protection Agency acceptance of the Record of Decision for Operable Unit 6 at Elmendorf Air Force Base.

Chuck Clarke

CHUCK CLARKE
Regional Administrator
Region X
U.S. Environmental Protection Agency

12-4-96
Date

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**SUPPORT AGENCY ACCEPTANCE**

**OF THE RECORD OF DECISION,**

**ELMENDORF AIR FORCE BASE, OPERABLE UNIT 6**

The Alaska Department of Environmental Conservation concurs with the Record of Decision for Operable Unit 6 at Elmendorf Air Force Base.

Lynn J. Tomich Kent

fo KURT FREDRIKSSON
Director, Spill Prevention and Response
Alaska Department of Environmental Conservation

1/2/97
Date

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# PART II

# DECISION SUMMARY

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## LIST OF FIGURES

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# Section 1.0
# INTRODUCTION

This Decision Summary provides an overview of the problems posed by the contaminants at Elmendorf Air Force Base (AFB) Operable Unit (OU) 6. It identifies the areas considered for remedial response, describes the remedial alternatives considered, and analyzes those alternatives compared to the criteria set forth in the National Contingency Plan (NCP). The Decision Summary explains the rationale for selecting the remedy, and how the remedy satisfies the statutory requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

The decision summary for OU 6 is divided by source area due to the diversity encountered between the six source areas within the OU. Reference is made to those discussions which are generic to the entire operable unit between the various source area sections to avoid redundancy. One additional source outside of OU 6 is also briefly addressed in this decision summary.

The following subsections describe the general setting of Elmendorf AFB and OU 6, including a brief physical description, discussion of the OU 6 land use, hydrogeology, and groundwater use. The OU 6 site history and enforcement activities, including the identification of activities which led to the current contamination at OU 6, the OU 6 regulatory and enforcement history, the role of the response action, and community participation, are also addressed in this introductory section. Source area specific historical and enforcement activities, as well as detailed site descriptions, are provided in the specific source area sections. Source Area SS19 is also discussed in this section. This source is not included within OU 6, but is addressed in this Record of Decision (ROD).

## 1.1 Site Description

The following subsections describe the physical description, land use, groundwater use, and hydrogeology of OU 6.

### 1.1.1 Physical Description

Elmendorf AFB is located approximately 2 miles north of downtown Anchorage (Figure 1.1-1). The base provides defense for the United States through surveillance, logistics, and communications support. OU 6 is the final OU at Elmendorf AFB, and consists of six source areas, including WP14, LF04, SD15, LF02, LF03 and SD73. These sites are located across the base, as depicted in Figure 1.1-2. Three of these sites are located on the northern portion of the base, on what is known as the Elmendorf Moraine. These are Sources WP14 [Petroleum, Oils, and Lubricants (POL) Sludge Disposal Site No. 1], LF04 (the Knik Bluff Landfill), and SD15 (POL Sludge Disposal Site No. 2). The other three sources are located in the southeastern portion of the base on the glacial outwash plain south of Ship Creek. These are Sources LF02 (a landfill located west of the Davis Highway and Oil Well Road), LF03 (the Hospital Road Landfill), and SD73 (the surface disposal area surrounding a former United States Geological Survey rock testing laboratory).

In general, the OU 6 source areas are in undeveloped areas of the base and are heavily vegetated with trees or shrubs. The exception to this is SD73, which has a primary cover of grass or weeds. The OU 6 source areas range in size from several acres to several tens of acres and are primarily devoid of buildings or other significant man-made features other than unimproved gravel roads. More detail on each source area is provided in the source area specific sections.

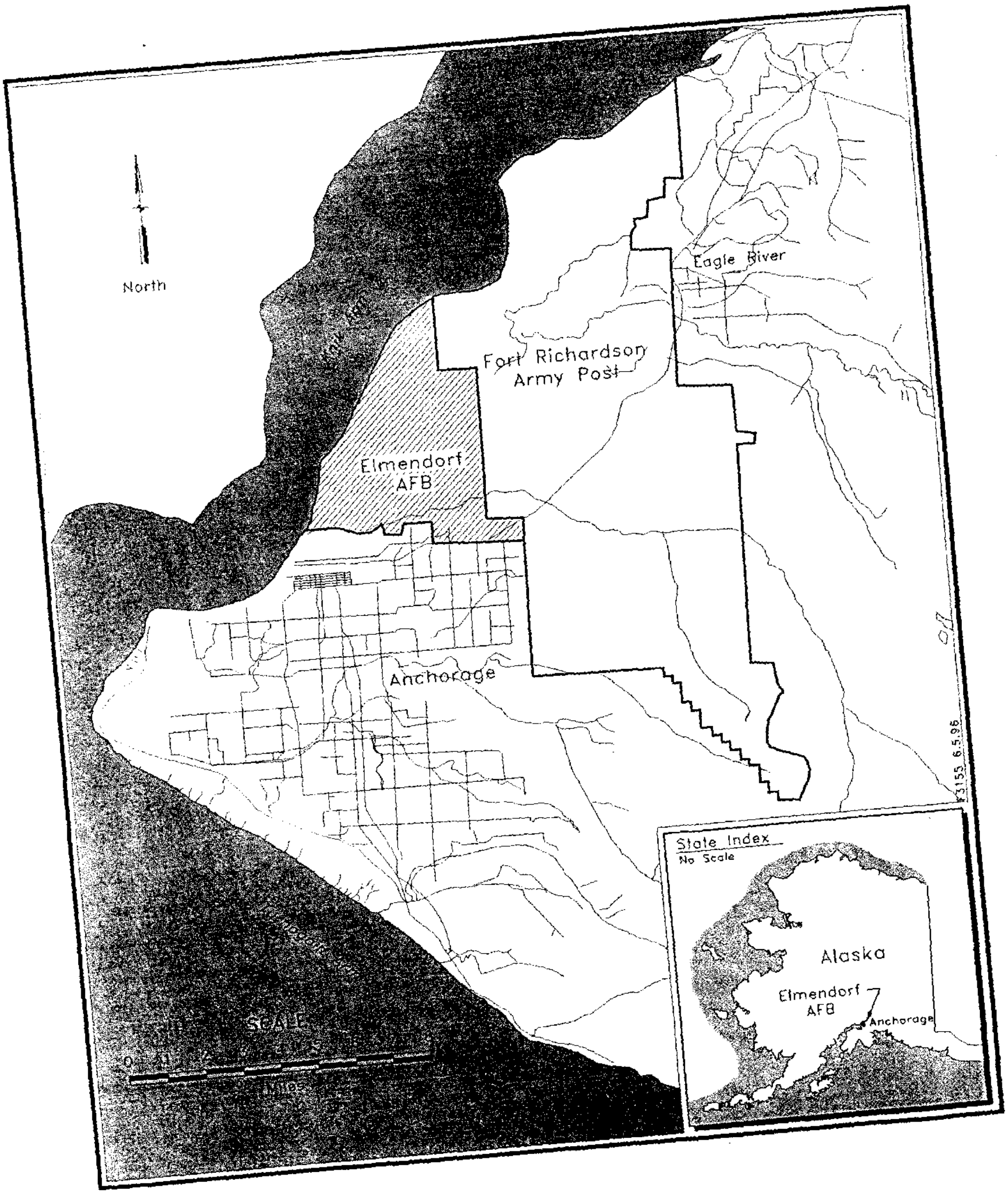


**Figure 1.1-1. Elmendorf AFB Site Location Map**

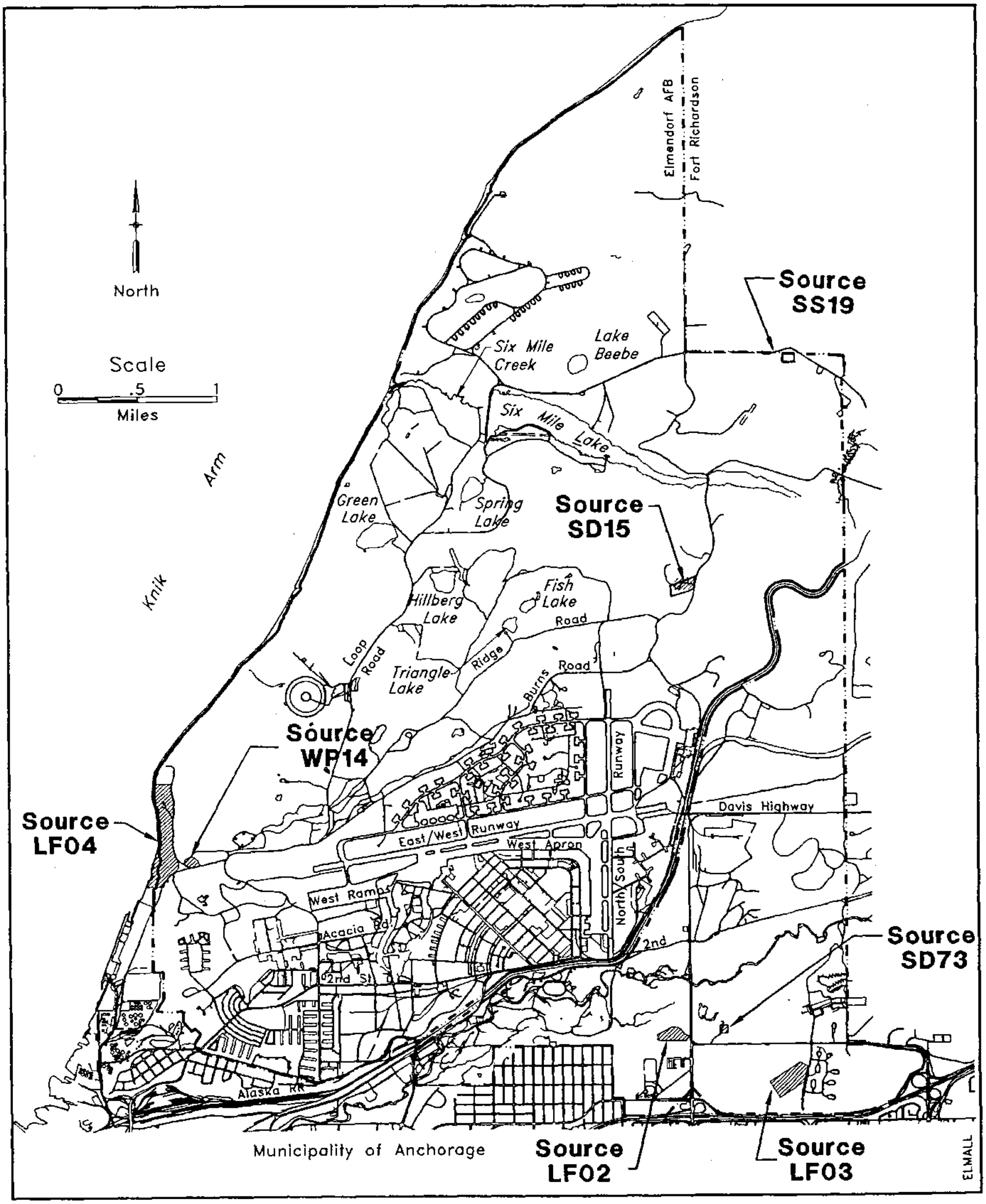


Figure 1.1-2. Location of OU 6 Source Areas and Source Area SS19


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### 1.1.2 Land Use

The land use for OU 6 is either open space or "restricted." Each of the former OU 6 landfills have building restrictions as addressed in the Base Comprehensive Plan. None of the OU 6 sites have been developed for industrial or residential purposes, with the exception of SD73, which has been used for light industrial activities in the past. Land use for SD73 may be changed to residential in the future.

### 1.1.3 Hydrogeology and Groundwater Use

The OU 6 source areas are located in two major hydrogeologic regimes, known as the "outwash plain" and the "Elmendorf Moraine." The glacial outwash plain is composed predominantly of sand and gravel. The moraine is composed primarily of sands, silts, and clays. In general, two aquifers underlie the base, an unconfined shallow aquifer and a deep confined aquifer. The aquifers are separated by the Bootlegger Cove Formation, which is an impermeable layer composed of silts and clays. Block diagrams depicting the hydrogeologic conceptual model for each source area, including the identification of each aquifer, are presented in the specific source area sections.

The hydrogeology of the shallow aquifer differs substantially between the moraine and outwash plain source areas due to the different lithologies present. For this reason, the shallow aquifer is described in detail in the source area specific sections, along with the groundwater use for that aquifer. Since the Bootlegger Cove Formation was only encountered at LF04, limited site specific information is available for that formation. As a consequence, it is described generically below, along with the deep confined aquifer, which was not encountered during the OU 6 Remedial Investigation/Feasibility Study (RI/FS). It is anticipated, but not confirmed, that the Bootlegger Cove formation and the deep confined aquifer underlie all of the OU 6 source areas.

The Bootlegger Cove Formation is made up of a series of clays, sands, and silts, which interfinger with the coarser grained units of the shallow aquifer above. The Bootlegger Cove is typically about 50 feet thick, but its actual thickness has only been measured in limited areas on base. The top of the Bootlegger Cove should occur at a depth of approximately 100 feet below ground surface (bgs) underlying the OU 6 source areas on the outwash plain, and approximately 170 feet bgs on the moraine. This formation outcrops along the beach at LF04.

The deep aquifer at OU 6 underlies and is confined by the Bootlegger Cove Formation, and occurs at an estimated depth of between 150 feet bgs (outwash plain), and 220 feet bgs (moraine). This aquifer is up to 550 feet thick. While the Bootlegger Cove Formation forms the principal confining unit, the confined aquifer may also be overlain by substantial thicknesses of other fine grained materials. Groundwater flow in the aquifer is to the west-northwest toward Knik Arm.

The deep aquifer at Elmendorf AFB has supplied large quantities of water for light industrial use such as air conditioning cooling water (no treatment), and aircraft and vehicle wash water (chlorination only) in the past. There are several inactive or abandoned base wells believed to be screened in the deep aquifer near OU 6. None of these wells were sampled during the Remedial Investigation (RI). Base Well 50, near SD73, was believed to be screened in the deeper aquifer but was found to be screened in the shallow aquifer during the RI. This well was inactivated during the investigation. The base wells screened in the deep aquifer are used for backup drinking water supply.

A hydraulic communication test conducted at Base Well 42 in OU 2 indicated there is no communication between the shallow aquifer and the confined aquifer. This result, coupled with the comparison of data from base water supply wells screened in the deep aquifer and data collected from nearby wells screened in the shallow aquifer, demonstrate the competency of the Bootlegger Cove Formation as an aquitard between the unconfined and confined aquifers.

## 1.2 Site History and Enforcement Activities

The following subsections detail the contaminant history of OU 6, the regulatory and enforcement history, the role of the response action, and the role of the community in defining the response.

### 1.2.1 Identification of Activities Leading to the Current Contamination at OU 6

OU 6 is composed of three former landfills, two sludge disposal pits, and a surface disposal area around a rock testing laboratory. Past landfill and general waste management practices are the principal reason for the contamination present at these sites. In addition, several fuel lines and the associated valves and storage tanks associated with the base fueling facilities are located within OU 6 source areas. These fuel systems have, at times, leaked fuel into the soil and groundwater surrounding these facilities. Specific activities leading to the current contamination at OU 6 are addressed in the source area specific sections in this Record of Decision (ROD).

The activities which contributed to past contamination at OU 6 are no longer taking place. The landfills have been closed since the early 1980s, and surface disposal of fuel wastes has not been conducted since 1983. As far as fuel related leaks are concerned at OU 6, the POL lines at LF04 and WP14 have been tested and determined to be sound. In addition, the underground storage tank (UST) and associated contaminated soils in the vicinity of the pumphouse (Building 30-790) at LF04 were removed in 1996, and the pumphouse was taken out of service.

Environmental investigations have been conducted at OU 6 since the early 1980s. Several studies discovered evidence of contamination in various parts of OU 6. The majority of these investigations were broadly focused across Elmendorf AFB and covered only portions of the source areas currently included in OU 6.

The first investigation to examine contamination throughout much of the area was done in 1990 (Black and Veatch, 1990). Only WP14, LF03, and SD15 were addressed in this investigation. The initial study was followed in 1993 by a Limited Field Investigation (LFI) of SD15 (Radian, 1993b) and an Environmental Baseline Assessment (Radian, 1993a) where SD73 was investigated further. Additionally, the State-Elmendorf Environmental Restoration Agreement (SERA) Phase 1B Site Assessment (ENSR, 1993) reevaluated contamination at LF02. Following these investigations, a full scale Remedial Investigation (RI) was conducted at OU 6 in 1994. The RI determined the nature and extent of contamination, and the potential risks to public health and the environment. The results were compiled and analyzed in the RI report (USAF, 1996b). Alternatives for remedial action were evaluated in detail in the OU 6 Feasibility Study (FS), submitted with the RI in January of 1996 (USAF, 1996b).

The RI/FS concluded that soil was contaminated in limited areas with fuel constituents resulting from past waste management activities, or leaking abandoned fuel pipelines. Areas of exposed landfill debris were also identified, with associated lead contamination at LF02. Several specific sources of groundwater contamination were identified, including the fuel lines at LF04 and WP14, the pumphouse at LF04, and the sludge weathering pads at SD15. Solvent contamination was also identified at SD15 and was attributed to the waste management activities conducted at that site.

### 1.2.2 Regulatory and Enforcement History

Based on the results of environmental investigations, Elmendorf AFB was listed on the

National Priorities List by the U.S. Environmental Protection Agency (USEPA) in August 1990. This listing designated the facility as a federal site subject to the remedial response requirements of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA). On 22 November 1991, the U.S. Air Force (USAF), the USEPA, and the Alaska Department of Environmental Conservation (ADEC) signed the Federal Facilities Agreement (FFA) for Elmendorf AFB. The contaminated areas of Elmendorf AFB were divided into seven OUs, each to be managed as a separate region and investigated according to varying schedules.

## 1.3 Scope and Role of Response Action

OU 6 is the last Operable Unit to be investigated at Elmendorf AFB, and as such is comprised of a mixed assemblage of source areas. OU 6 was originally defined in the FFA to include only LF04, WP14, and LF03. LF02 was added in late 1993 after the evaluation of the SERA Phase 1B Site Assessment results (ENSR, 1993). Similarly, Source Area SD15 was added to OU 6 in 1993 based upon the conclusions reached in the Limited Field Investigation (LFI) conducted at that site (Radian, 1993b), and SD73 was added following evaluation of the results of an Environmental Baseline Assessment conducted at the National Oceanographic and Atmospheric Administration (NOAA) facility where SD73 is located (Radian, 1993a).

In accordance with the FFA, an RI of OU 6 was conducted in the summer of 1994. The RI determined the nature and extent of contamination, and the potential risks to public health and the environment. The results were compiled and analyzed in the RI Report (USAF, 1996b). The RI concluded that fuel, fuel constituents, and low levels of solvents were present in soil and groundwater in OU 6. Low levels of pesticides and other contaminants were also found. Isolated areas of elevated fuel constituents were detected in the soils at the location of leaks or spills. In addition, plumes of dissolved fuel and solvent constituents were identified in the groundwater.

The Final RI/FS was submitted in January 1996 (USAF, 1996b). A Proposed Plan (USAF, 1996a) was distributed to the public on 1 April 1996, and a public meeting to discuss the plan was held on 17 April 1996. The index of documents entered into the Administrative Record for OU 6 is provided as Appendix A.

The CERCLA process described above is intended to identify solutions to contamination issues where they exist. The remedial action described in this ROD addresses threats to human health and the environment posed by contamination at OU 6. The RI/FS Report defines these threats as both groundwater and soil contaminants. At this time, both soil and groundwater will be actively treated where the contaminants pose a significant future threat to human health. Groundwater and soil will both be monitored to evaluate contaminant migration, and to track the progress of contaminant dispersion and degradation, as well as to provide an early warning of any unforseen environmental or human health risk. In addition, contaminated landfill soil will be covered with a clean soil cover, and landfill debris exposed at the surface will be removed and disposed. Further response actions, coordinated with the regulatory agencies, may be considered if monitoring finds unacceptable contaminant migration occurring, or unacceptable reduction in contaminant concentrations over time.

## 1.4 Community Participation

Public participation has been an important component of the CERCLA process at Elmendorf AFB. Activities aimed at informing and soliciting public input regarding base environmental programs include:

- **Environmental Update:** Environmental Update is a newsletter distributed to the community and interested parties. It discusses the progress that has been made on OU and advises the public about opportunities to provide input concerning decisions to address contaminated areas of the base. Aspects of the OU 6 CERCLA progress have been published in this newsletter.

- **Community Relations Plan:** The base environmental personnel maintain and regularly update a Community Relations Plan. It describes how the base will inform the public of base environmental issues, and it solicits public comment on base environmental programs.

- **The Restoration Advisory Board/Technical Review Committee:** Base personnel meet regularly with representatives of the community to discuss base environmental programs and solicit their comments.

- **Public Workshops:** On 5 February 1992, approximately 75 people attended a public workshop where base personnel discussed base environmental programs and encouraged public participation.

- **Videotape:** Base personnel made a videotape describing base environmental activities. The tape is shown to base employees as well as the general public.

- **Speakers Bureau:** The 3rd Wing Public Affairs Office maintains a speakers bureau capable of providing speakers versed in a variety of environmental subjects to military and civic groups.

- **Newspaper Releases:** News releases are published on significant events during the Installation Restoration Program (IRP). News releases are made announcing all public meetings that are held to discuss proposed remedial actions.

- **Information Repositories:** Public access to technical documents is provided through information repositories located at the Bureau of Land Management's Alaska Resources Library and the University of Alaska at Anchorage's Consortium Library. The information in the repositories is also maintained in the administrative record.

- **Display Board:** During public functions, a display board, showing key elements and progress of the Elmendorf IRP, is used to communicate technical issues to the public. It is used during both on-base and off-base events.

- **Proposed Plan:** The OU 6 Proposed Plan was distributed to the public on 1 April 1996, a public meeting was held 17 April 1996, and the public review period was from 2 April to 3 May 1996. Comments from the public are contained in Part III, Responsiveness Summary, of this document.

- **Public Notice:** Public notices have been issued prior to all significant decision points in the IRP. For OU 6, public notice was issued for the Proposed Plan in the *Anchorage Daily News* (3/31/96) and the *Sourdough Sentinel* (3/29/96).

- **Mailing List:** A mailing list of parties interested in the restoration program is maintained by the base. Notices and publications (news releases including the OU 6 Proposed Plan meeting) are released via the mailing list.

- **Responsiveness Summary:** Public comments were received on the OU 6 Proposed Plan. The USAF maintains a record of all comments and has published responses to the comments in this ROD.

All decisions made for OU 6 were based on information contained in the Administrative Record. An index to the documents contained in the Administrative Record for OU 6 is provided as Appendix A.

## 1.5 Source Area SS19

In addition to the six source areas addressed as part of OU 6, one additional source area, SS19, is included in this ROD. SS19 consists of a bunker in the extreme northeast corner of the base (Figure 1.1-2). This building was used during the early 1960s to temporarily store pesticides before disposal. No records indicate that spills or releases have occurred. This building is currently used by the Base Civil Engineering Squadron for equipment storage.

A Limited Field Investigation (LFI) was conducted at this site in 1993. During the LFI, surface and subsurface soil samples were collected and analyzed for pesticides. Laboratory analyses of the samples indicated dieldrin was present above risk based concentrations and soil action levels in soils at depths ranging from 0 to 3 feet. As a result of the LFI, it was determined that no further action would be warranted at this site if contaminated soils were removed.

In 1995, soil was excavated from the west side of the bunker to one foot below grade. Samples taken at the base of the excavation indicated that dieldrin was still present in some areas of the initial excavation. These areas were further excavated an additional foot below grade. Following this, confirmatory base and sidewall samples indicated that all pesticide contaminated soils had been removed down to a risked-based level of 136 parts per billion (ppb), a concentration at which the residual risk is within an acceptable range (5.1E-06) assuming residential use and exposure. The site was backfilled with clean granular fill material. Because the contaminated soils at SS19 have been satisfactorily removed, and the residual risk is at an acceptable level, no further action is required.

# SECTION TWO

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# Section 2.0
# SOURCE WP14

The following subsections present the physical description, land use, groundwater use, and hydrogeology of WP14. The identification of activities which led to the current contamination at WP14 is also included. The discussion of the regulatory and enforcement history of WP14, the role of the response action at WP14, and community participation in the response action are included in the general OU 6 discussion in Section 1.0.

## 2.1 Site Description

Source WP14 (POL Sludge Disposal Site No. 1), located a few hundred feet to the east of Source LF04 (Figure 1.1-2), consists of an area approximately 400 feet by 300 feet, that was used from 1964 to 1968 to dispose of sludge generated from POL tank cleanout operations. The area was also used to weather fuel filters and pads left on the ground surface. The source area was closed with natural soil cover. Figure 2.1-1 depicts the general layout of Source WP14.

This source area is located at an elevation of approximately 200 feet above mean sea level (msl). The terrain at this source area slopes slightly to the west and surface drainage takes place in the general direction of Knik Arm. The ground surface has been altered by construction activities and is currently covered by low alder growth. Active and inactive underground fuel pipelines run through this site. Scattered metallic debris (heavy equipment parts) is present on the southern portion of the source area.

### 2.1.1 Land Use

The land use designation for WP14 is open space in the Base Comprehensive Plan. There are no known historic buildings, archeological sites, wetlands, floodplains, or rare or endangered species at WP14.

### 2.1.2 Hydrogeology and Groundwater Use

This section describes the specific hydrogeology and groundwater use at Sources WP14 and LF04. The discussion of the hydrogeologic settings at Sources WP14 and LF04 have been combined because of their close proximity on the Elmendorf Moraine. The regional geology and hydrogeology at Elmendorf AFB is discussed in Section 1.0. A more detailed discussion of the geology and hydrogeology of OU 6 is presented in the OU 6 RI/FS Report (USAF, 1996b).

Sources LF04 and WP14 are located on the Elmendorf Moraine, which overlies the Bootlegger Cove Formation. The moraine deposits consist of predominantly clay-rich sections containing discontinuous lenses of sand and gravel. The hydrogeology of the moraine deposits at Source LF04 and WP14 appears to be complex and highly dependent upon the lithology, porosity, and lateral extent of the water bearing zones. What can be considered a shallow unconfined aquifer from a regional point of view was determined to be a series of perched aquifers at varied depth intervals. The series of aquifers are depicted in the hydrogeologic conceptual model presented as Figure 2.1-2.

Three distinctive aquifer units were identified in the WP14/LF04 area. Groundwater flow in the uppermost aquifer is predominantly to the west and steepens as the aquifer approaches the bluff. The groundwater gradient of the first aquifer is approximately 325 feet per mile in the east, but steepens to about 700 feet per mile to the west. At WP14, the depth to this first aquifer ranges from approximately 10 to 40 feet bgs. The aquifer is slightly deeper at LF04. In the second aquifer,



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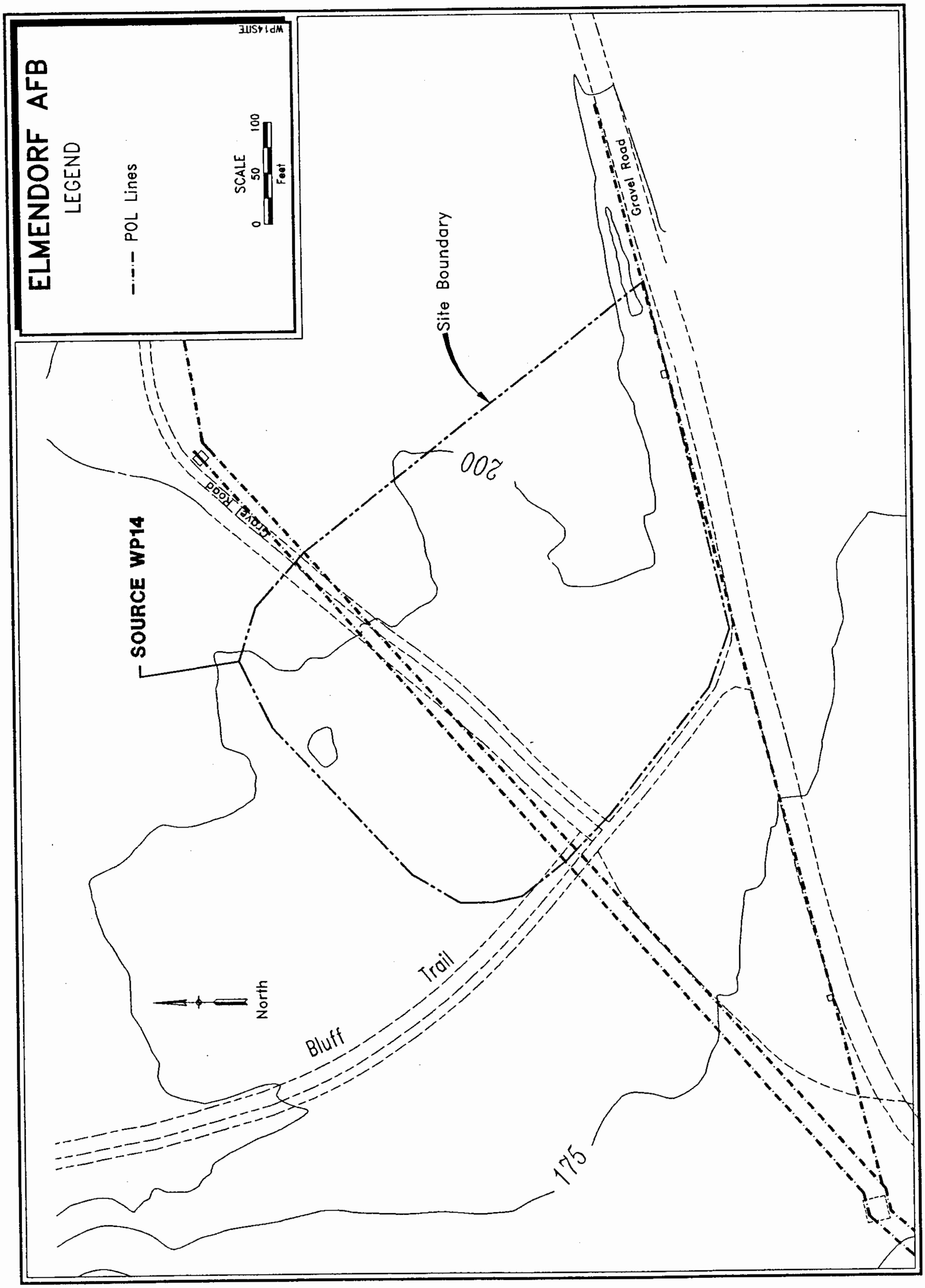


Figure 2.1-1. Location Map for Source Area WP14



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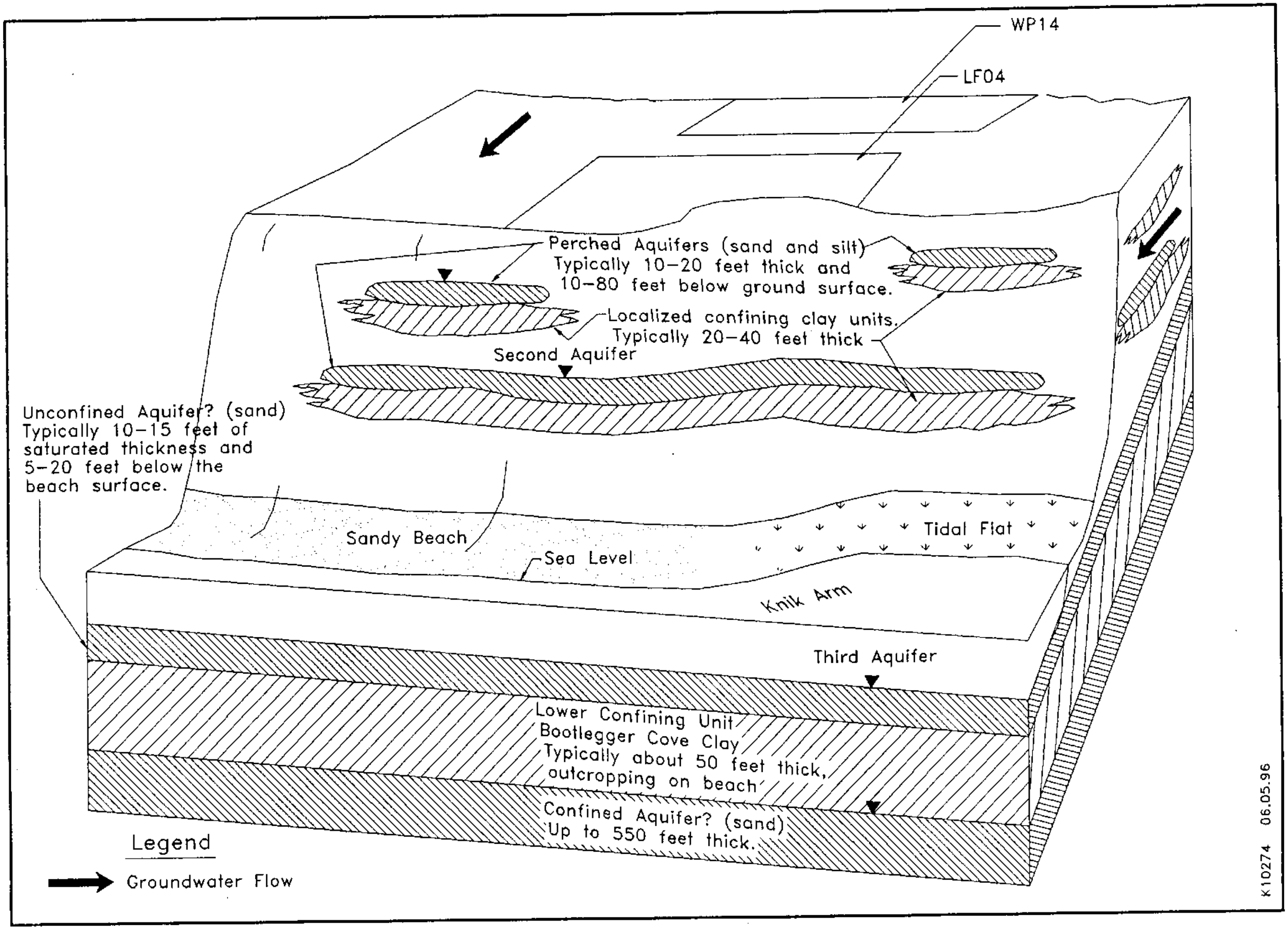


Figure 2.1-2. Conceptual Hydrogeologic Model for WP14 and LF04





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groundwater flow remains primarily to the west. The calculated groundwater gradient in the second aquifer is approximately 100 feet per mile.

The second aquifer is bounded by the bluff where LF04 overlooks the Knik Arm and partially discharges as seeps along the bluff face. Seeps were observed at about 90 to 110 feet above sea level in the bluff above the Knik Arm. The elevation of these seeps appears to be controlled by the presence of a clay layer which could coincide with the top of the Bootlegger Cove Formation. The aquifer occurs at a depth of about 70 feet bgs at WP14, and from about 70-110 feet bgs at LF04. The first and second aquifers appear to communicate in a mixing zone located roughly along the eastern boundary of LF04.

The third groundwater aquifer at LF04 is at or near the beach level (Figure 2.1-2). This aquifer was below the deepest depth bored to and therefore was not encountered during drilling at WP14. Groundwater movement in the third aquifer is west to the Knik Arm. Gradients along the beach and lower bluff face are relatively steep, at approximately 530 feet per mile. Groundwater seeps observed at the base of the bluff appear to discharge water from the water-sorted aquifer at the base of the bluff. The second aquifer also communicates with the beach level aquifer in a separate mixing zone.

The presence of mixing zones between the various aquifers allows for vertical hydraulic connection between the three different aquifers in WP14/LF04. Both of these mixing zones trend roughly perpendicular to groundwater flow. The estimated hydraulic conductivity for this area ranges from 1.12E-3 to 3.59E-5 cm/sec in the various perched aquifers.

The groundwater in the shallow aquifer on base is not used for any purpose. Its future use, even if the aquifer was uncontaminated, is generally limited because of the higher yield of the deeper confined aquifer underlying the Bootlegger Cove Clay. In the vicinity of WP14, the fine-grained nature of the perched aquifer materials, and the laterally discontinuous nature of the perched aquifer lenses, would make these aquifers wholly unsuitable as drinking water supply aquifers. Groundwater in the deep aquifer on base is unaffected by contamination at WP14 or LF04, and remains as an alternate water supply source.

## 2.2 Site History and Enforcement Activities

The following section identifies the activities which led to the current contamination at WP14. The regulatory and enforcement history for WP14 is included in the general discussion presented for OU 6 in Section 1.0, as are the discussions of the role of the response action and the community participation in the response.

### 2.2.1 Identification of Activities Leading to the Current Contamination at WP14

The contaminants identified in the groundwater at WP14 include primarily fuel-related species, solvents, and metals. Fuel-related constituents and metals were also the most commonly occurring contaminants in the soil.

Among the sources of contamination identified at WP14, the most obvious is the disposal of POL sludge. Residual fuels and solvents were made available to leach into the soil and groundwater as a result of the disposal of tank sludge and the weathering of fuel filters and pads in the area. This activity is likely responsible for most of the surface soil contamination present at the site. Second, abandoned and active POL lines that run through the source area in a northeastwardly direction from Source LF04 (southwest) to Operable Unit 2 Source ST41 (northeast) were identified

(Figure 2.1-1). During the 1994 RI, an additional abandoned POL line was located. This line trends approximately west to east through the southern portion of Source WP14 between Sources LF04 and ST41 (Figure 2.1-1). Other POL facilities such as valve pits, were identified at WP14 in close proximity to contaminated soil areas. The POL sources are likely contributors to the fuel-related contamination present. This determination was made because subsurface soil contamination appears to be oriented in relation to the fuel pipelines at the site, suggesting leaks from the lines as the probable contaminant source. Groundwater contamination at WP14 also appears to emanate from the vicinity of the two inactive POL lines. Removal of these inactive POL lines is currently being planned under the UST program. A schematic of the potential migration and exposure pathways for fuels and solvents through the soil and into the groundwater is presented in Figure 2.2-1 for Sources WP14 and LF04, since they are in such close proximity.

Contaminated soil zones lying above the water table represent a "smear zone" of contamination resulting from fuel and solvent constituents that migrated to a higher water table and were left in the vadose zone as the water table declined. This smearing of contamination may occur between seasons as the water table elevation changes. Downward percolation of groundwater through contaminated soils at WP14 can also act as a contaminant source for the shallow aquifer.

Prior to the RI conducted at WP14 in 1994, WP14 had been addressed under the following studies:

- IRP Phase I/II Records Search and Statement of Work (Engineering-Science, 1983);
- IRP Phase II Stage 3 Work Plan (Harding Lawson, 1988);
- Resource Conservation and Recovery Act (RCRA) Facility Assessment Report (ADEC, 1988); and
- IRP Phase III, Stages 3 and 4, Remedial Investigation/Feasibility Study (Black and Veatch, 1990).

The active POL line at WP14 has been tested and determined to be sound. Both inactive POL lines were reportedly drained prior to being abandoned in sections. The weathering and disposal of POL sludge has been discontinued at WP14 since 1968.

## 2.3 Site Contamination, Risks, and Areas Requiring Response Actions

This section identifies the areas which were investigated, and those that require remedial action. These areas were chosen based on the risk that contaminants pose to human health and the environment. The basis of this analysis is the data collected during the RI which identified the nature and extent of contamination at WP14.

### 2.3.1 Nature and Extent of Contamination

During the RI, samples of soil and groundwater were collected and analyzed. Significant levels of contaminants were detected in both the soil and groundwater at WP14. These contaminants include fuels and fuel constituents, metals, and semi-volatile organic compounds (SVOCs). The contamination present at WP14 is associated with percolation of contaminants through the soil to the groundwater, transport of dissolved contaminants with the groundwater, and volatilization of contaminants. These transport mechanisms are pictorially represented for WP14 in Figure 2.2-1.

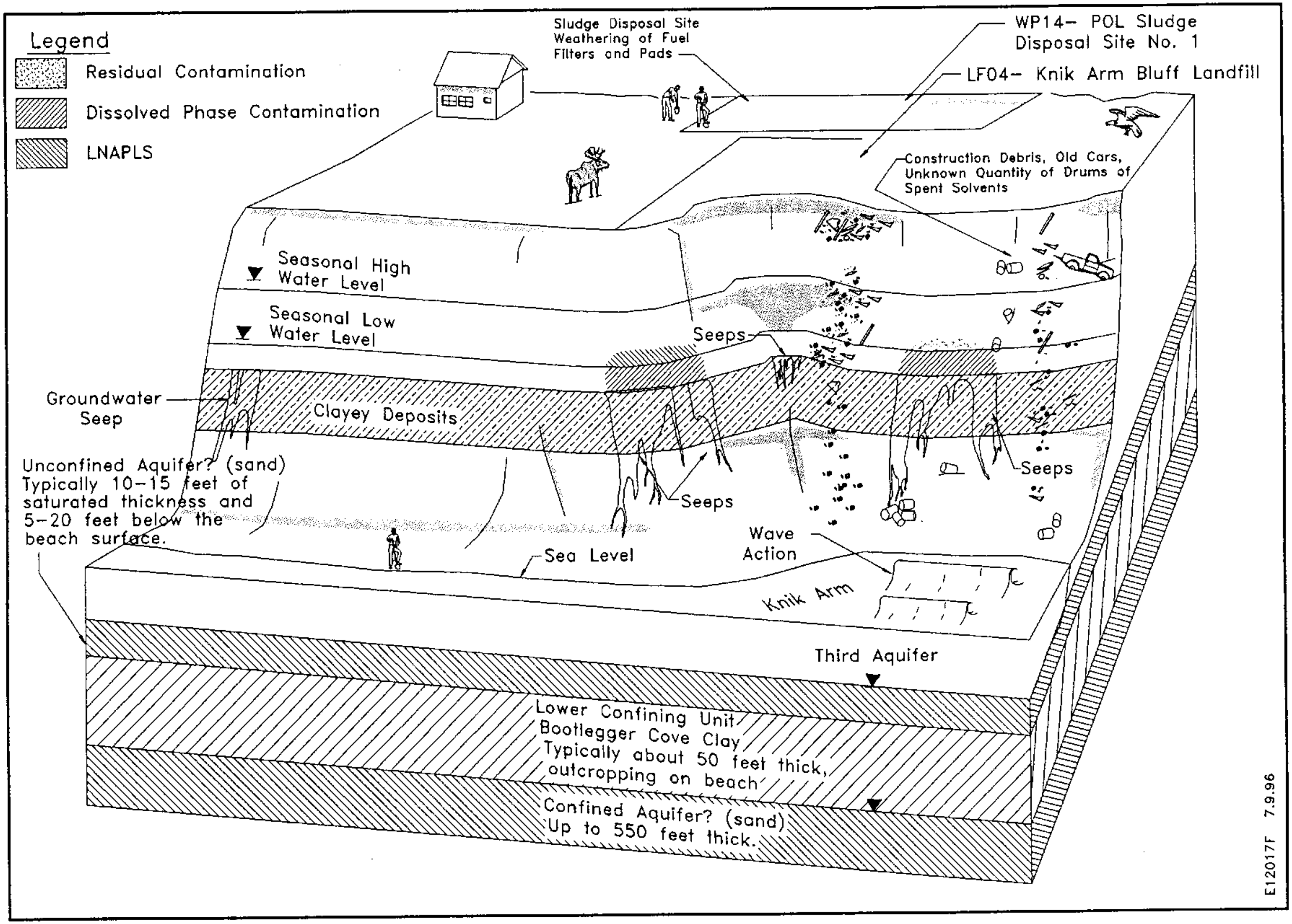


Figure 2.2-1. Contaminant Release Mechanisms and Pathways for Exposure at WP14 and LF04

Tables 2.3-1 through 2.3-3 list the frequency of occurrence and maximum concentrations of all constituents which were detected during the RI in groundwater and soil. The tables do not include results below the detection limit. The Maximum Contaminant Levels (MCLs) for groundwater and the Alaska Cleanup Matrix (ACM) guidelines for soil are also listed on the tables for all constituents. Results are separated between "indicator parameters" and "contaminant parameters." Indicator parameters primarily include metals classified as nutrients, and non-speciated fuel constituents such as unidentified diesel range organics (UDRO) which are unsuitable for use in a risk assessment. Indicator parameters are typically not hazardous constituents but are important for determining general water quality, sustaining growth of microbial cultures, and interpreting results of other analyses. A detailed discussion of the determination of the contaminants of concern (COCs) for WP14 is presented in Section 2.3.3.

**Groundwater Contamination at WP14**

The predominant type of groundwater contamination detected at WP14 is benzene, toluene, ethylbenzene and xylene (BTEX) constituents and fuels. The highest BTEX concentrations are found in the sample from MW-12 (Table 2.3-1). Benzene was detected at a maximum concentrations of 1390 $\mu$g/L in a sample from that well. BTEX constituents were detected in samples from every well at WP14. Maximum weathered fuel constituents were detected in samples from MW-12, MW-46 and MW-06. Additionally, less than 1 inch of free phase floating product was detected at MW-12 during field testing in 1995.

Low levels of chlorinated solvents, including a maximum detection of 2.45 $\mu$g/L in a sample from MW-12 were also detected. Similar low levels of solvents have been detected in numerous monitoring wells on base at other sites within OU 6 and at other OUs. SVOCs were also detected in the groundwater at WP14, with the maximum detection occurring in a sample from MW-12 at 4130 $\mu$g/L bis(2-ethylhexyl) phthalate. This elevated concentration is believed to be the result of degradation of the polyvinyl chloride (PVC) well casing in the presence of elevated levels of fuel constituents, rather than being the result of improper waste disposal activities at WP14.

Numerous metals were also detected in the groundwater at WP14. These include relatively low concentrations of barium, beryllium, cadmium, chromium, cobalt, copper, manganese, nickel, vanadium, and zinc (Table 2.3-1). In the evaluation of the metals concentration at WP14, a comparison to background metals concentrations was conducted. Background metals concentrations in groundwater were collected by the U.S. Geological Survey (USGS) in the Anchorage Bowl area and compiled in the *Elmendorf Air Force Base, Alaska, Basewide Background Sampling Report* (USAF, 1993). These metals data have been used historically at Elmendorf AFB for comparison with on-site groundwater metals concentrations. Confidence intervals of the USGS data for a given metal were compared with confidence intervals for the WP14 analytical results for the same analyte. If the confidence intervals of the two means overlapped, the two means were considered not to be different and the particular metal was removed from consideration as a COC. Based on this evaluation, all metals in groundwater at WP14 were determined to be at or near background concentrations. The summary statistics for the USGS data, including the upper confidence limit concentrations used for these comparisons, are presented in Table 2.3-4.

**Soil Contamination at WP14**

Soil data from WP14 were evaluated based upon surface and subsurface contaminant occurrences. Surface soils include all soils collected from depths shallower than 3 feet bgs. Subsurface soils are those collected from below 3 feet. Tables 2.3-2 and 2.3-3 list the sample depths, maximum concentrations, locations, and guidelines associated with the ACM for non-UST soil for all contaminant

## Table 2.3-1

## Summary of Groundwater Analytical Results for Source WP14
## Elmendorf AFB, AK

| Method (units) | Analyte | MCL[1] | Maximum Result | Frequency of Detections Total Hits/ Total Samples | Location of Maximum Result |
|---|---|---|---|---|---|
| **Indicator Parameters** | | | | | |
| SW8015ME (µg/L) | Unidentified organics [UDRO] | -- | 2310 | 9/12 | MW-06 |
| SW8015MP (µg/L) | Unidentified organics [UGRO] | -- | 119000 b | 10/12 | MW-12 |
| | Xylene (total) | 10,000 | 7080 | 12/12 | MW-12 |
| SW6010, Total (mg/L) | Aluminum | -- | 31.1 | 7/12 | MW-12 |
| | Calcium | -- | 109 | 12/12 | MW-13 |
| | Iron | -- | 52.5 | 12/12 | MW-12 |
| | Magnesium | -- | 30.8 | 12/12 | MW-46 |
| | Potassium | -- | 5.15 | 12/12 | MW-12 |
| | Sodium | -- | 9.31 | 12/12 | MW-46 |
| SW6010, Dissolved (mg/L) | Aluminum | -- | 0.0704 B | 1/2 | MW-12 |
| | Calcium | -- | 32.7 | 2/2 | MW-12 |
| | Iron | -- | 0.0606 B | 2/2 | MW-12 |
| | Magnesium | -- | 8.4 | 2/2 | MW-12 |
| | Potassium | -- | 1.57 | 2/2 | MW-12 |
| | Sodium | -- | 4.41 | 2/2 | MW-12 |
| **Contaminant Parameters** | | | | | |
| SW8015ME (µg/L) | Jet fuel (JP-4) | -- | 554000 | 3/12 | MW-12 |
| SW8015MP (µg/L) | Gasoline | -- | 167 | 1/12 | MW-15 |
| SW8260 (µg/L) | Acetone | -- | 24.3 b | 12/12 | MW-06 |
| | Benzene | 5 | 1390 | 12/12 | MW-46 |
| | 2-Butanone(MEK) | -- | 18.6 F | 3/12 | MW-12 |
| | Chloroethane | -- | 0.48 | 3/12 | MW-46 |
| | Chloroform | 100 | 0.25 | 2/12 | MW-12 |
| | Chloromethane | -- | 3.2 | 12/12 | MW-15 |
| | 1,1-Dichloroethane | -- | 1.04 | 2/12 | MW-12 |
| | 1,1-Dichloroethene | 7 | 0.29 | 1/12 | MW-12 |
| | 1,2-Dichloroethane | 5 | 2.45 | 5/12[2] | MW-12 |
| | Ethylbenzene | 700 | 1410 | 12/12 | MW-12 |
| | 2-Hexanone | -- | 2.61 | 1/12 | MW-15 |
| | Methylene chloride | 5 | 3.9 B | 8/12 | MW-06 |
| | 4-Methyl-2-pentanone(MIBK) | -- | 3.04 F | 5/12 | MW-12 |
| | Toluene | 1000 | 3190 | 12/12 | MW-12 |
| | 1,1,1-Trichloroethane | 200 | 0.56 | 1/12 | MW-12 |
| | Trichloroethene | 5 | 0.8 | 1/12 | MW-12 |
| | m&p-Xylene | -- | 4360 | 12/12 | MW-12 |
| | o-Xylene | -- | 1480 | 12/12 | MW-12 |
| SW8270 (µg/L) | Benzoic acid | -- | 37.2 | 1/12 | MW-06 |
| | Dimethylphthalate | -- | 110 | 5/12 | MW-12 |
| | Di-n-octylphthalate | -- | 49.6 | 1/12 | MW-12 |

## Table 2.3-1

## (Continued)

| Method (units) | Analyte | MCL[1] | Maximum Result | Frequency of Detections Total Hits/ Total Samples | Location of Maximum Result |
|---|---|---|---|---|---|
| SW8270 (µg/L) (continued) | bis(2-Ethylhexyl)phthalate | 6 | 4130 | 3/12 | MW-12 |
| | 2-Methylnaphthalene | -- | 630 | 4/12 | MW-12 |
| | Naphthalene | -- | 384 | 4/12 | MW-12 |
| SW6010, Total (mg/L) | Barium | 2 | 0.241 | 12/12 | MW-12 |
| | Beryllium | 0.004 | 0.00212 B | 7/12 | MW-46 |
| | Cadmium | 0.005 | 0.00715 | 3/12 | MW-46 |
| | Chromium | 0.1 | 0.102 | 2/12 | MW-12 |
| | Cobalt | -- | 0.0237 | 7/12 | MW-12 |
| | Copper | 1.3[3] | 0.11 | 2/12 | MW-12 |
| | Manganese | -- | 6.45 | 12/12 | MW-06 |
| | Nickel | 0.1 | 0.0934 | 2/12 | MW-12 |
| | Vanadium | -- | 0.091 | 3/12 | MW-12 |
| | Zinc | -- | 0.246 | 9/12 | MW-12 |
| SW7060, Total (mg/L) | Arsenic | 0.05 | 0.038 | 2/12 | MW-12 |
| SW7421, Total (mg/L) | Lead | 0.015[3] | 0.648 | 2/12 | MW-12 |
| SW6010, Dissolved (mg/L) | Barium | 2 | 0.0254 | 2/2 | MW-12 |
| | Manganese | -- | 5.27 | 2/2 | MW-12 |
| | Zinc | -- | 5.27 | 2/2 | MW-12 |
| SW7060, Dissolved (mg/L) | Arsenic | 0.05 | 0.00337 | 1/2 | MW-12 |
| SW7421, Dissolved (mg/L) | Lead | 0.015[3] | 0.0317 | 2/2 | MW-12 |

[1] Maximum contaminant level (MCL); 40 CFR § 141.61 for Federal MCLs, and 18 AAC 80.070 for State MCLs. Federal and State MCLs are identical for the listed constituents.

[2] Frequency "hits" calculation does not include one or more results removed from the data set because they did not meet QA/QC criteria. Total sample count includes all samples analyzed for the indicated parameter.

[3] From 40 CFR, Section 141.11 for inorganics and Section 141.12 for organics (effective 1 July 1991); however, the lead level is effective only until 7 December 1992. There is no longer an MCL for lead or copper (56 Federal Register 26460, June 7, 1991); however, there is an action level of 0.015 mg/L for lead and 1.3 mg/L for copper.

b - Due to high concentrations of other target compounds in the sample, or to interference by non-target analytes, the sample could not be run at a dilution factor of one. The flagged analyte concentration is less than the blank UTL times the sample dilution factor.

B - Sample concentration was less than or equal to the blank UTL.

F - Co-elution or interference was suspected.

## Table 2.3-2

### Summary of Surface Soil Analytical Results for Source WP14
### Elmendorf AFB, AK

| Method (units) | Analyte | ACM | Background Upper Tolerance Limit | Maximum Result | Frequency of Detection total hits/ total samples | Location of Maximum Result |
|---|---|---|---|---|---|---|
| **Indicator Parameters** | | | | | | |
| SW9045 (pH units) | pH | -- | -- | 6.44 | 2/2 | SS-050 |
| D2216 (percent) | Percent moisture | -- | -- | 36.4 | 24/24 | SB-47 |
| SW8015ME (mg/kg) | Unidentified organics [UDRO] | 1000 | -- | 555 | 24/24 | SB-04 |
| SW8015MP (mg/kg) | Unidentified organics [UGRO] | 500 | -- | 2.7 B | 9/24 | SS-057 |
| SW6010 (mg/kg) | Aluminum | -- | 31183.96 | 28900 | 24/24 | SB-14 |
| | Calcium | -- | 8013.23 | 11100 | 24/24 | MW-12 |
| | Iron | -- | 43192.35 | 38800 | 24/24 | SB-14 |
| | Magnesium | -- | 10904.10 | 10500 | 24/24 | SB-14 |
| | Potassium | -- | 845.75 | 1680 | 24/24 | SB-14 |
| | Sodium | -- | 427.05 | 336 | 24/24 | MW-12 |
| **Contaminant Parameters** | | | | | | |
| SW8015MP (μg/kg) | Benzene | 500 | -- | 12.1 B | 3/24 | SS-60 |
| | Ethylbenzene | 50000 | -- | 119 | 2/24 | MW-06 |
| | Gasoline | 500000 | -- | 9230 | 1/24 | SS-060 |
| | Toluene | 50000 | -- | 75.4 | 8/24 | SS-58 |
| | Xylene (total) | 50000 | -- | 113 | 7/24 | SS-060 |
| SW8240 (μg/kg) | Acetone | -- | -- | 48 B | 20/24 * | SS-055 |
| | 2-Butanone(MEK) | -- | -- | 35.9 | 14/24 | SS-054 |
| | Chloroform | -- | -- | 144 | 4/24 | MW-06 |
| | Methylene chloride | -- | -- | 3.82 B | 3/24 | SB-08 |
| | m & p-Xylene | 50000 | -- | 68.2 | 2/24 | MW-06 |
| | o-Xylene | 50000 | -- | 29.3 | 2/24 | MW-06 |
| SW8270 (μg/kg) | bis(2-Ethylhexyl)phthalate | -- | -- | 0.698 | 6/24 | SS-056 |
| | 2-Methylnaphthalene | -- | -- | 0.785 | 3/24 | SS-057 |
| | 2-Methylphenol (o-cresol) | -- | -- | 0.0951 | 2/24 | MW-06 |
| | Phenol | -- | -- | 0.0262 B | 1/24 | MW-06 |
| SW6010 (mg/kg) | Antimony | -- | NA | 9.67 | 5/24 | SS-049 |
| | Barium | -- | 196.45 | 350 | 24/24 | SB-04 |
| | Beryllium | -- | 0.76 | 0.615 | 24/24 | SB-14 |
| | Chromium | -- | 48.44 | 47.3 | 24/24 | SB-14 |
| | Cobalt | -- | 19.52 | 16.5 | 24/24 | SB-14 |
| | Copper | -- | 31.67 | 55.1 | 24/24 | MW-06 |
| | Manganese | -- | 929.98 | 881 | 24/24 | SB-09 |
| | Molybdenum | -- | NA | 2.12 | 18/24 | SS-054 |
| | Nickel | -- | 50.68 | 41.6 | 24/24 | SB-14 |

## Table 2.3-2

## (Continued)

| Method (units) | Analyte | ACM | Background Upper Tolerance Limit | Maximum Result | Frequency of Detection total hits/ total samples | Location of Maximum Result |
|---|---|---|---|---|---|---|
| SW6010 (mg/kg) cont. | Selenium | -- | 0.54 | 15.4 | 14/24 | SB-07 |
| | Silver | -- | 1.68 | 0.728 | 1/24 | SB-14 |
| | Vanadium | -- | 101.64 | 88.9 | 24/24 | SS-054 |
| | Zinc | -- | 90.01 | 75.1 | 24/24 | SS-054 |
| SW7060 (mg/kg) | Arsenic | -- | 13.27 | 15.5 | 24/24 | SS-054 |
| SW7421 (mg/kg) | Lead | -- | 10.69 | 18.6 | 24/24 | SB-04 |

*Frequency "hits" calculation does not include one or more results removed from the data set because they did not meet QA/QC criteria. Total sample count includes all samples analyzed for the indicated parameter.
ACM - Alaska Cleanup Matrix, Level C.
B - Sample concentration was less than or equal to the blank UTL.
NA - Not applicable.
X - The recoveries of one or more of the internal standards were outside the applicable acceptance criteria. The X-flag indicates which compounds were quantitated using the affected internal standard(s).

## Table 2.3-3

## Summary of Subsurface Soil Analytical Results for Source WP14
## Elmendorf AFB, AK

| Method (units) | Analyte | ACM Guideline[1] | Background Upper Tolerance Limit | Maximum Result | Depth of Maximum Result (ft) | Frequency of Detection Total Hits/ Total Samples | Location of Maximum Result |
|---|---|---|---|---|---|---|---|
| **Indicator Parameters** | | | | | | | |
| SW9045 (pH units) | pH | -- | -- | 8.53 | 22 | 3/3 | SB-14 |
| D2216 (percent) | Percent moisture | -- | -- | 29.3 | 7 | 66/66 | SB-47 |
| SW8015ME (mg/kg) | Unidentified organics [UDRO] | 1000 | -- | 291 | 8 | 26/31 | SB-03 |
| SW8015MP (mg/kg) | Unidentified organics [UGRO] | 500 | -- | 6670 | 17 | 20/35 | MW-06 |
| SW6010 (mg/kg) | Aluminum | -- | 18116.77 | 29800 | 8 | 31/31 | SB-03 |
| | Calcium | -- | 10264.39 | 17600 | 34 | 31/31 | MW-15 |
| | Iron | -- | 38483.64 | 38700 | 8 | 31/31 | SB-03 |
| | Magnesium | -- | 14784.34 | 14000 | 42 | 31/31 | SB-14 |
| | Potassium | -- | 1114.35 | 2740 | 8 | 31/31 | SB-03 |
| | Sodium | -- | 365.59 | 871 | 42 | 31/31 | SB-14 |
| **Contaminant Parameters14** | | | | | | | |
| SW8015M (mg/kg) | Diesel | 1000 | -- | 135 E | 14 | 4/31 | SB-09 |
| | Jet fuel (JP-4) | 1000 | -- | 2050 | 17 | 1/31 | MW-12 |
| SW8015MP (µg/kg) | Benzene | 500 [2] | -- | 1830 P | 17 | 9/35 | MW-06 |
| | Ethylbenzene | -- [2] | -- | 22200 | 22 | 11/35 | MW-12 |
| | Gasoline | 500000 | -- | 3140000 | 17 | 4/35 | MW-12 |
| | Toluene | -- [2] | -- | 39700 | 17 | 13/35 | MW-12 |
| | Xylene (total) | -- [2] | -- | 93200 | 22 | 16/35 | MW-12 |
| SW8240 (µg/kg) | Acetone | -- | -- | 367 | 14 | 28/35 [3] | SB-09 |
| | 2-Butanone(MEK) | -- | -- | 72.1 | 14 | 25/35 [3] | SB-09 |
| | Chloroform | -- | -- | 26.4 | 12 | 5/35 | MW-06 |
| | Methylene chloride | -- | -- | 23.6 | 12 | 12/35 | SB-07 |
| | 4-Methyl-2-pentanone(MIBK) | -- | -- | 22.3 | 10.5 | 3/35 | SB-01 |
| | m & p-Xylene | -- [2] | -- | 99400 | 17 | 9/35 | MW-12 |
| | o-Xylene | -- [2] | -- | 1730 | 17 | 8/35 | MW-12 |
| SW8270 (mg/kg) | Benzo(a)anthracene | -- | -- | 0.0202 F | 32 | 1/31 | SB-14 |
| | Chrysene | -- | -- | 0.0342 | 34 | 3/31 | SB-14 |
| | Dibenzofuran | -- | -- | 0.0215 | 42 | 1/31 | SB-04 |
| | Di-n-octylphthalate | -- | -- | 0.285 | 7 | 2/31 | SB-47 |
| | bis(2-Ethylhexyl)phthalate | -- | -- | 0.568 | 7 | 4/31 | SB-47 |
| | Fluorene | -- | -- | 0.0235 | 34 | 1/31 | MW-15 |
| | 2-Methylnaphthalene | -- | -- | 1.66 | 14 | 14/31 | SB-09 |
| | Naphthalene | -- | -- | 0.277 | 22 | 9/31 | SB-07 |
| | Phenanthrene | -- | -- | 0.0952 | 34 | 5/31 | SB-14 |



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## Table 2.3-3

## (Continued)

| Method (units) | Analyte | ACM Guideline[1] | Background Upper Tolerance Limit | Maximum Result | Depth of Maximum Result (ft) | Frequency of Detection Total Hits/ Total Samples | Location of Maximum Result |
|---|---|---|---|---|---|---|---|
| SW6010 (mg/kg) | Antimony | -- | NA | 7.42 | 35.5 | 8/31 | MW-05 |
| | Barium | -- | 95.93 | 141 | 8 | 31/31 | SB-03 |
| | Beryllium | -- | 0.64 | 0.65 | 8 | 31/31 | SB-03 |
| | Chromium | -- | 76.94 | 46.1 | 8 | 31/31 | SB-03 |
| | Cobalt | -- | 17.62 | 17.3 | 11 | 31/31 | SB-01 |
| | Copper | -- | 59.84 | 57.8 | 7 | 31/31 | SB-09 |
| | Manganese | -- | 709.45 | 822 | 11 | 31/31 | SB-01 |
| | Molybdenum | -- | NA | 1.95 | 42 | 28/31 | SB-04 |
| | Nickel | -- | 71.79 | 44.9 | 11 | 31/31 | SB-01 |
| | Selenium | -- | 0.48 | 16.7 | 8 | 17/31 | SB-04 |
| | Silver | -- | 1.06 | 0.716 | 34 | 6/31 | MW-15 |
| | Thallium | -- | NA | 5.7 | 34 | 1/31 | MW-15 |
| | Vanadium | -- | 66.16 | 88.4 | 8 | 31/31 | SB-03 |
| | Zinc | -- | 76.17 | 89.4 | 11 | 31/31 | SB-01 |
| SW7060 (mg/kg) | Arsenic | -- | 9.31 | 15.8 | 34 | 30/31 | SB-14 |
| SW7421 (mg/kg) | Lead | -- | 10.13 | 22.8 S | 8 | 31/31 | SB-03 |

[1] Alaska Cleanup Matrix (ACM) Level C; 18 AAC 78.315.
[2] The ACM Level C guideline for benzene, toluene, ethylbenzene, and xylenes (BTEX) combined is 50,000 $\mu$g/kg.
[3] Frequency "hits" calculation does not include one or more results removed from the data set because they did not meet QA/QC criteria. Total sample count includes all samples analyzed for the indicated parameter.

E - Analyte exceeded calibration range, but did not saturate the detector; therefore, data is usable.
F - Co-elution or interference was suspected.
NA - Not applicable.
P - Analyte quantitation not confirmed. Results from primary and secondary GC columns differ by greater than a factor of three.
S - Metal concentration reported was obtained using the method of standard additions.



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Table 2.3-4

**Summary Statistics for Background USGS Groundwater Analytical Data**
**Elmendorf AFB, AK**

| Analyte | Background Summary Statistics[a], (mg/L) | | | | |
|---|---|---|---|---|---|
| | Method | Hits | Min. | Max. | Mean |
| Aluminum | Unknown | 0/1 | ND | ND | NC |
| Antimony | Unknown | 21/28 | ND | 0.014 | 0.002 |
| Antimony | Unknown | 21/28 | ND | 0.014 | 0.002 |
| Arsenic | Unknown | 28/28 | 0.001 | 0.130 | 0.029 |
| Arsenic | Unknown | 28/28 | 0.001 | 0.130 | 0.029 |
| Barium | NA | NA | NA | NA | NA |
| Beryllium | Unknown | 0/10 | ND | ND | NC |
| Cadmium | Unknown | 2/28 | ND | 0.001 | NC |
| Calcium | NA | NA | NA | NA | NA |
| Chromium | Unknown | 27/28 | ND | 0.350 | 0.043 |
| Cobalt | NA | NA | NA | NA | NA |
| Copper | Unknown | 28/28 | 0.001 | 1.10 | 0.094 |
| Cyanide | NA | NA | NA | NA | NA |
| Lead | Unknown | 13/28 | ND | 0.300 | 0.028 |
| Magnesium | NA | NA | NA | NA | NA |
| Manganese | Unknown | 28/28 | 0.150 | 64.00 | 6.81 |
| Mercury | Unknown | 14/21 | ND | 0.001 | 0.000 |
| Molybdenum | NA | NA | NA | NA | NA |
| Nickel | Unknown | 26/28 | ND | 1.000 | 0.093 |
| Nitrate-Nitrite as N | NA | NA | NA | NA | NA |
| Potassium | NA | NA | NA | NA | NA |
| Selenium | Unknown | 0/10 | ND | ND | NC |
| Silver | Unknown | 1/10 | ND | 0.001 | NC |
| Thallium | Unknown | 0/10 | ND | ND | NC |
| Vanadium | NA | NA | NA | NA | NA |
| Zinc | Unknown | 25/28 | ND | 3.50 | 0.242 |

[a] Background obtained from USGS.
NA - No data available.
NC - Not calculated due to insufficient data.
ND - Not detected.



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parameters in the surface and subsurface soil samples at WP14. Results below the detection limits are not included in the analytical summary tables.

Organic contamination at WP14 consists primarily of weathered residuals from fuels. BTEX constituents were detected in both surface and subsurface soils. The levels in the subsurface soils exceeded those of the surface soils, with the maximum BTEX occurrence being xylene at 93,200 $\mu$g/kg in a soil sample from the MW-12 pilot boring. The maximum fuel detection, for gasoline, also occurred in a sample from the MW-12 boring. Low levels of other organics, such as chloroform and methylene chloride were also detected in both surface and subsurface soils, as were low levels of SVOCs. The SVOCs are believed to be weathered residuals from fuels. The discussion of soil COCs for WP14 is presented in Section 2.3.3.

Metals were also identified at WP14, and were determined to be at or near background concentrations. The background results used in the metals evaluation at WP14 are included in the soil analytical tables (Tables 2.3-2 and 2.3-3). Background soil analytical data were collected in association with the basewide background sampling effort (USAF, 1996b). During the background soil investigation, 60 soil samples were collected from 14 soil borings drilled at background locations at the base. The analytical results associated with these samples were pooled into surface and subsurface soil results, and were used as the basis to conduct statistical comparisons with on-site results. With the possible exception of lead as an additive in fuels, there are no known anthropogenic sources for the metals detected at WP14.

### 2.3.2 Risk Evaluation

Based on the concentrations of contaminants detected during the RI, human health and environmental risk assessments were performed to determine if areas should be considered for remedial action. All concentrations of contaminants, including all contaminants of concern, whether exceeding MCLs or ACM guidelines or not, were included in the risk assessments. The subsections below include the general discussion of the human health and ecological risk assessment procedures followed for OU 6. As the procedures for each of the source areas within OU 6 were identical, this discussion will be referenced in the site specific sections for the other OU 6 source areas.

#### Human Health Risk Assessment (HRA)

By determining under what land use conditions people are potentially exposed to what chemicals, for how long, and by what pathways of exposure, the cancer and noncancer risks were determined in the RI/FS (USAF, 1996b).

**Exposed Populations and Exposure Pathways** -- Listed below are the four exposure scenarios evaluated in the human health risk assessment. Details on the parameters used in the Health Risk Assessment are shown on Table 2.3-5.

- **Future Residential:** The HRA evaluated exposure of residents to contaminated shallow soil through direct contact (incidental ingestion and dermal absorption) and inhalation of dusts. Their exposure to shallow aquifer groundwater through ingestion, inhalation (showering), and dermal contact (showering) was also evaluated.

- **Construction (Trench) Worker:** The HRA evaluated exposure of short term construction workers to contaminated deep soil through direct contact (incidental ingestion and dermal absorption) and inhalation of dusts.

## Table 2.3-5

### Exposure Assumptions[1] for Evaluation of Carcinogenic Risk and Non-carcinogenic Hazard Indices Elmendorf AFB, AK

| Parameter | On-Site Residential Adult RME | On-Site Residential Child RME | Subsurface Occupational or Trench Worker RME | Visitor Adult RME | Visitor Child RME |
|---|---|---|---|---|---|
| Body Weight (kg) | 70 [a] | 15 [a] | 70 [a] | 70 [a] | 15 [a] |
| Exposure Duration (yrs) | 30 [a] | 6 [d] | 1 [c] | 30 [c] | 6 [c] |
| Averaging time (carcinogens) (yrs) | 70 [d] | NA | 70 [d] | 70 [d] | 70 [d] |
| Averaging time (noncarcinogens) (yrs) | NA | 6 [d] | 1 [d] | 30 [d] | 6 [d] |
| Total Inhalation rate ($m^3$/day) | 20 [d] | 16 [e] | 20 [d] | 20 [d] | 16 [e] |
| Soil Ingestion/Contact | | | | | |
| Soil Ingestion Rate (mg/day) | 100 [a] | 200 [a] | 480 [a] | 100 [c] | 200 [c] |
| Soil to Skin Adherence Factor (mg/$cm^2$) | 1 [f] | 1 [f] | 1 [f] | 1 [f] | 1 [f] |
| Exposed Skin ($cm^2$) | 5000 [b] | 3900 [b] | 3160 [f] | 5000 [b] | 1900 [b] |
| Exposure Frequency (days/yr) | 185 [g] | 185 [g] | 40 [c] | 12 [c] | 12 [c] |
| Water Use | | | | | |
| Water Ingestion (L/day) | 2 [a] | 0.7 [e] | NA | 1 [h] | 1 [h] |
| Indoor Inhalation Rate ($m^3$/day) | 15 [a] | 12 [c] | NA | NA | NA |
| Exposure Frequency (days/yr) | 350 [a] | 350 [a] | NA | 12 [h] | 12 [h] |
| Skin Surface ($cm^2$) | 23000 [f] | 10,600 [f] | NA | 820 [h] | 410 [h] |
| Duration of Dermal Contact with Water (min) | 15 [f] | 15 [f] | NA | 10 [h] | 10 [h] |

[1] Footnotes a-b and d-g refer to documents discussed in the Human Health Risk Assessment for OU 6 (USAF, 1996b).
[a] USEPA, 1991b.
[b] USEPA, 1991d.
[c] Assumption (USAF, 1996b).
[d] USEPA, 1989b.
[e] USEPA, 1989d.
[f] USEPA, 1992a.
[g] Barnack, 1994.
[h] Applies only to surface water seep exposure at Source LF04. Exposure to water was not evaluated as part of the visitor scenario at any other source areas.
NA - Not applicable.

- **Visitor:** The HRA evaluated exposure of an adult and child visitor to contaminated shallow soil through direct contact (incidental ingestion and dermal absorption) and inhalation of dusts. Exposure to seeps was also evaluated at applicable sites.

- **Lead Evaluation**: Exposure to lead in the soil was performed using the USEPA's Uptake/Biokenetic Model for lead. This model provides a prediction of blood lead concentrations based on diet, inhalation, and soil/dust intake for children 0-7 years of age.

Since WP14 is not currently used residentially, a *current* residential risk scenario was not evaluated and only current visitor and trench worker scenarios were applied. Even though the future land use at WP14 is limited as specified in the Base Comprehensive Plan, the *future* residential risk scenario was evaluated at WP14 to obtain the most conservative risk information possible.

**Exposure Assumptions** -- Risk can be calculated both for the average exposure and the reasonable maximum exposure (RME) of the population. All chemicals detected during sampling were evaluated as potential sources of cancer and noncancer health risks. In the case of metals, risks were only calculated if the metals concentrations exceeded background concentrations. For RME exposures, the statistically derived 95% Upper Confidence Limit (UCL) of the mean concentrations was used to calculate exposures. In instances where the 95% UCL concentration was greater than the maximum concentration detected, the maximum was used as the receptor exposure concentration.

Using exposure levels and standard values for the toxicity of contaminants, excess lifetime cancer risks (ELCRs), and hazard indices (HIs), were calculated to describe cancer and noncancer risks, respectively. The ELCR is the additional chance that an individual exposed to site contamination will develop cancer during his/her lifetime. It is expressed as a probability such as 1.0E-06 (one in a million). The HI estimates the likelihood that exposure to the contamination will cause some negative health effect. An HI score above one indicates that some people exposed to the contamination may experience at least one negative health effect.

ELCRs and HIs were calculated using Reference Doses (RfDs) and Cancer Slope Factors (CSFs), which represent the relative potential of compounds to cause adverse noncancer and cancer effects, respectively. Two sources of RfDs and CSFs were used for this assessment. The primary source was the Integrated Risk Information System (IRIS) database, the USEPA repository of agency-wide verified toxicity values. If a toxicity value was not available through IRIS, then the latest available quarterly update of the Health Effects Assessment Summary Tables (HEAST) issued by the USEPA's Office of Research and Development was used as a secondary source. For some chemicals detected at OU 6, no toxicity value from IRIS or HEAST was available, and toxicity values were provided by the USEPA Superfund Technical Support Center at the Environmental Criteria and Assessment Office in Cincinnati.

Table 2.3-6 summarizes the carcinogenic and noncarcinogenic human health risks calculated for WP14. The risks are based on hypothetical exposure to soil and groundwater. The shallow groundwater aquifer is not presently used, and will not be used in the future for supplying potable or non-potable water. For carcinogenic soil risk, the calculated results for the future resident (RME), construction worker, and visitor are listed. Only the future resident scenario (RME) was used to calculate carcinogenic groundwater risk. These risk values are also included in the table.

## Table 2.3-6

### Summary of Human Health Risks at WP14
### Elmendorf AFB, AK

| Risk | Surface Soil (<3 feet) | | Subsurface Soil | Chemical(s) Driving Risk |
|---|---|---|---|---|
| | Residential Scenario[a] | Visitor Scenario[b] | Trench Worker Scenario[c] | |
| **Soil Risk [d]** | | | | |
| Carcinogenic | 1.8E-05 | 1.0E-06 | <1.0E-06 | Arsenic |
| Non-Carcinogenic | 2.75 | 0.14 | NR | Arsenic, Manganese |
| **Groundwater Risk [d]** | | | | |
| Carcinogenic | 2.4E-03 | NA | NA | Benzene, bis 2-(ethylhexyl)plthalate, 1,2-Dichloroethane, 1,1-Dichloroethene, Toluene |
| Non-Carcinogenic | 16.8 | NA | NA | bis 2-(ethylhexyl)phthalate, 1,1-Dichloroethene, Toluene |

[a] Excess cancer risks conservatively assumed for 30 years of exposure (drinking groundwater, contact with soil, etc.) by future residents (Reasonable Maximum Exposure).
[b] Excess cancer risks conservatively assumed for 30 years of exposure while visiting the site under current conditions.
[c] Excess cancer risks conservatively assumed for 1 year of exposure during on-site construction work (digging, etc.).
[d] Risks are calculated by using the 95% upper confidence limits (UCLs) for contaminants present unless the 95% UCL exceeded the maximum concentration detected, in which case the maximum concentration was used. This represents a conservative estimate of the "worst case" contamination.
NA - Not applicable.
NR - Significant risk not identified.

Groundwater carcinogenic risk at WP14 exceeded 1.0E-03. Benzene is the predominant risk driver, with four other constituents, including solvents, an SVOC, and toluene, as the other risk contributors. Toluene is the primary contributor to the noncarcinogenic risk, which exceeded an acceptable HI of 1.0 in the residential scenario (RME). Soil carcinogenic risk at WP14 exceeded 1.0E-06 for the residential scenario, and is marginal for the visitor scenario. The noncarcinogenic risk for RME soils also exceeded 1.0. Risk to trench workers from deep soil is at an acceptable level. All soil risk was 100% attributable to metals contamination. The metals at WP14 are believed to be at background concentrations.

**Ecological Risk Assessment (ERA)**

The ERA was performed to determine if the reported concentrations of chemicals or calculated exposures to plants and wildlife at OU 6 are likely to produce adverse effects. Ecological effects were evaluated quantitatively by calculating Ecological Quotients (EQs). EQs are defined as the ratio between measured concentrations or predicted exposures, and critical effects levels. If an EQ is less than 1.0, the effect is unlikely to occur. Critical effects are defined in the selection of assessment and measurement endpoints. Assessment endpoints are the general environmental resource or value that is being protected. A measurement endpoint is a specific criterium that is used to evaluate the more general assessment endpoint.

Elmendorf AFB contains 13,095 acres, approximately 4,100 of which are developed. Twenty-nine types of terrestrial and aquatic vegetation have been reported on base, primarily in the undeveloped portions, such as OU 6. Mammal, bird and fish species are also common. No endangered or threatened species of animals or plants reside, or frequents the base. However, the peregrine falcon, a federally-listed endangered species, was identified as a low-frequency visitor during spring and fall migration.

The ERA focused on evaluating potential impacts of the contamination on selected indicator species: the moose, masked shrew, meadow vole, black-capped chickadee, merlin, and peregrine falcon. The spotted sandpiper was also identified as an indicator species for evaluating ecological risk on the beach.

The ecological quotient (EQ) of 1.0 was exceeded for the black capped chickadee, meadow vole, and shrew in soil at WP14 due to selenium concentrations. The highest EQs for selenium were associated with the masked shrew and equaled 180. The selenium EQs for the black capped chickadee and meadow vole were equal to or less than 3.3. None of the calculated EQs exceeded 1.0 for the moose, peregrine falcon, or merlin at WP14. It should be noted that the graphite furnace method (SW7740) was used to calculate selenium background UCLs, while the ICPES method (SW6010) was used to analyze for selenium in soils at WP14. There is substantial uncertainty associated with the results for concentrations near the detection limit for selenium associated with SW6010 due to interferences. Since the maximum selenium result in the soils at WP14 was only approximately three times the detection limit, and SW7740 data are not available, it is highly likely that the data used to calculate the EQs for selenium at WP14 are not representative of actual selenium concentrations, and may be biased high. Therefore, it appears that there is a low potential for ecological risk due to selenium at this source area. No significant impacts to plants or animals warranting action were determined to be present based on the results of the ERA.

**Uncertainties Associated with the Risk Assessment**

Risk assessments involve calculations based on a number of factors, some of which are uncertain. The effects of the assumptions and the uncertainty factors may not be known. Usually, the effect is difficult to quantify numerically, so the effect is discussed qualitatively. Some of the major assumptions and uncertainty factors associated with the risk assessment are the following:

- Existing concentrations are assumed to be the concentrations in the future. No reduction through natural degradation and attenuation over time is taken into account (may overestimate risk).
- No increase through additional contamination is assumed (may underestimate risk).
- The use of total rather than dissolved metals data for groundwater is problematic due to the undefined contribution added by the particulate material added in the unfiltered samples (may overestimate risk).
- Potential degradation products of existing organic contaminants are not considered (may overestimate or underestimate risk).
- Potential effects on the indicator species are assumed to be representative of other animals at OU 6 (may overestimate or underestimate risk).

### 2.3.3 Conclusions

The following subsections provide a discussion of the determination of COCs for WP14; the location and extent of contamination by COCs in excess of preliminary remediation goals; and a summary statement about the risk to public health, welfare, or the environment if action is not taken at WP14.

**Contaminants of Concern**

Constituents exceeding preliminary remediation goals (MCLs for groundwater or ACM guidelines for soils) were identified in the Proposed Plan. COCs were developed from the results of the risk assessment and by considering preliminary remediation goals. Each constituent having an individual contribution of greater than 1.0E-06 carcinogenic (RME) risk, or an HI greater than 0.1 when the cumulative HI for the site is greater than 1.0, was considered as a COC. In addition, any constituent exceeding preliminary remediation goals (MCLs for groundwater or ACM guidelines for soil) was also considered as a COC. The final COCs for WP14 are shown on Table 2.3-7, with the individual risk contributed and basis for identifying the COC (risk or regulatory standard).

Three COCs were identified for groundwater at WP14: benzene, ethylbenzene, and toluene (Table 2.3-7). These constituents contribute to a broad plume of contamination in the groundwater at WP14, depicted in Figure 2.3-1. The plume map is drawn based upon concentrations exceeding 5 $\mu$g/L, which is the MCL for benzene. This map is combined with the contaminant plume map for LF04, since the groundwater beneath these two source areas is interconnected, as discussed in Section 2.1. The groundwater plume at WP14 emanates from groundwater monitoring wells MW-46 and MW-06, which were two of the principal wells contaminated with fuels identified in the nature and extent of contamination discussion. Groundwater contamination from WP14 represents an upgradient source for the groundwater contamination at LF04. The combined plume from WP14 and LF04 is estimated to contain 45.5 million gallons of fuel contaminated groundwater.

The Proposed Plan identified two additional groundwater constituents as exceeding regulatory levels: bis(2-ethylhexyl)phthalate and cadmium. Bis(2-Ethylhexl)phthalate was not

**Table 2.3-7**

**Summary of Contaminants of Concern[1] at WP14**
**Elmendorf AFB, AK**

| Chemical | Maximum Concentration | Maximum Cancer Risk | Maximum Hazard Index | Basis for COC | Remediation Goal | Basis for Remediation Goal |
|---|---|---|---|---|---|---|
| **Groundwater:** | | | | | | |
| Benzene | 1390 µg/L | 2.0E-03 | -- | Exceeds MCL; contributes to a risk > 1.0E-06 | 5 µg/L | MCL |
| Ethylbenzene | 1410 µg/L | -- | -- | Exceeds MCL | 700 µg/L | MCL |
| Toluene | 3190 µg/L | -- | 12 | Exceeds MCL; contributes to HI > 1 | 1000 µg/L | MCL |
| **Shallow Soils** (0-5 feet bgs): (No COCs for Shallow Soils) | | | | | | |
| **Deep Soils** (>5 feet bgs): (No COCs for Deep Soils) | | | | | | |

1 Cancer risk ≥ 1.0E-06 or HI ≥ 0.1 for soil or groundwater scenario with a total HI of ≥ 1.0; or concentrations found in excess of regulatory levels. If cancer risk or HI did not exceed standards, it was marked as "--".
bgs - Below ground surface
COC - Contaminant of concern
MCL - Maximum Contaminant Level (40 CFR § 141.61 for Federal MCLs; 18 AAC 80.070 for State MCLs). Federal and State MCLs are identical for the COCs.





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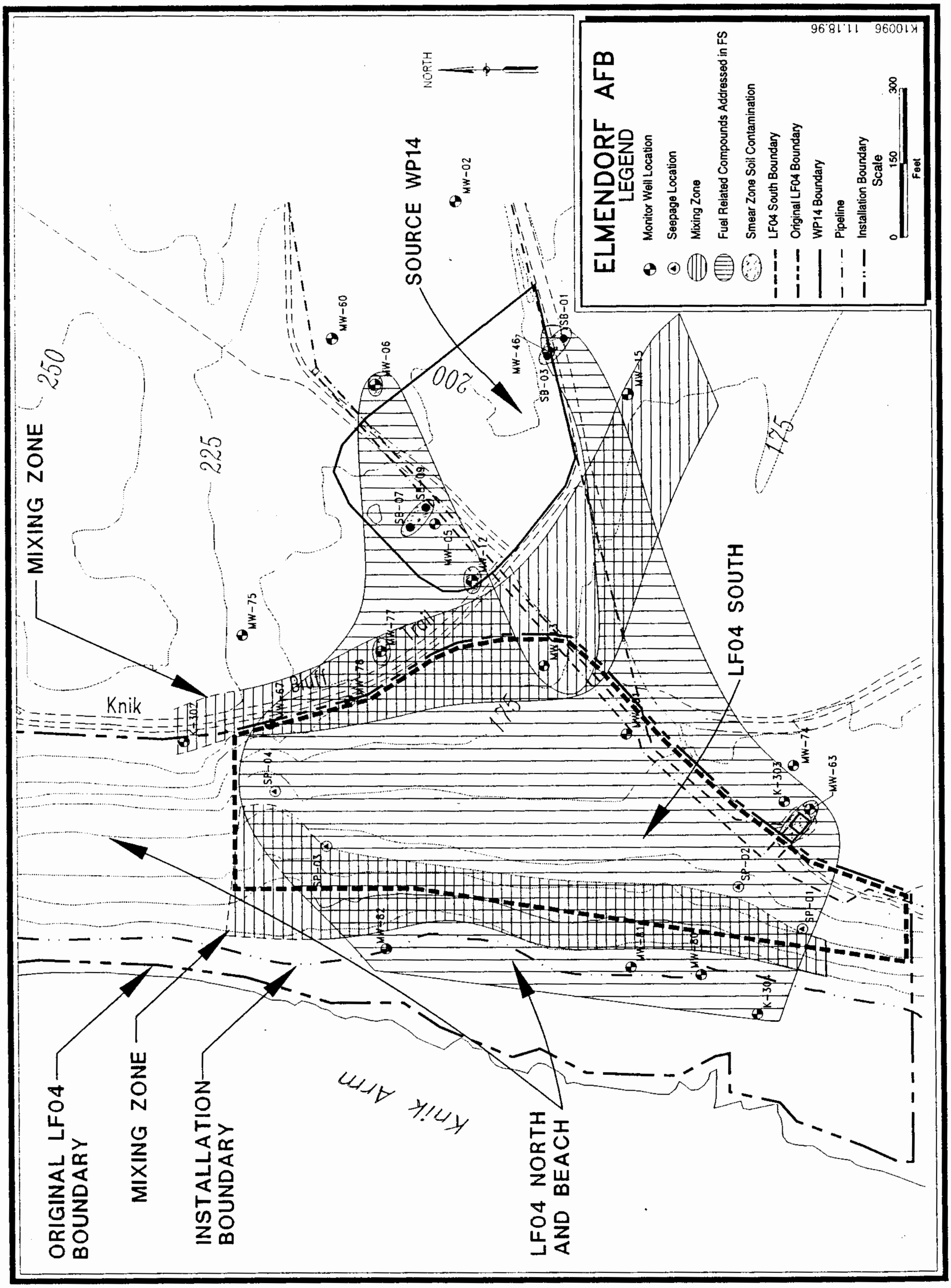


**Figure 2.3-1. Fuel Plume in the Groundwater at WP14/LF04 South**

identified as a COC in the ROD because detection of this compound can be associated with sampling in the presence of fuel and not with historic land uses. Cadmium was not identified as a COC, because it did not contribute to significant risk and only marginally exceeded the MCL in one of 12 samples. Chromium levels in groundwater also marginally exceeded the MCL, but their concentrations were determined to be statistically below background levels. Cadmium and chromium were also detected only in the total metals analysis.

No COCs were identified for soils at WP14. A cancer risk of 1.8E-05 was calculated for soils at WP14. This risk was within the acceptable risk range of 1.0E-04 to 1.0E-06. Furthermore, this risk was attributable to metals in the soils which were determined to be comparable to background concentrations.

As specified in the Proposed Plan, fuel constituents were detected in excess of ACM Level B guidelines in both deep (greater than 5 feet bgs) and shallow (less than 5 feet bgs) soils. For shallow soils, DRO exceeded ACM Level B. During preparation of the OU 6 ROD, the ACM scoring criteria were reexamined and consensus was reached between ADEC, USEPA, and USAF that ACM Level C was more appropriate at WP14. ACM Level C would be protective of human health and the environment and is more stringent than the level being used at similar sites elsewhere. DRO concentrations in the shallow soils at WP14 did not exceed ACM Level C; therefore, no COCs were established for shallow soils.

The Proposed Plan also listed DRO, GRO, benzene, and BTEX as deep soil contaminants that exceeded cleanup guidelines. A treatability study conducted at WP14 in August 1996 determined that this contamination is in the smear zone. Because smear zone soil contamination is believed to be the result of groundwater contaminants adhering to exposed soil particles during periods where the water table is low, these contaminants are indistinguishable from groundwater contamination. Therefore, smear zone contamination will be addressed as part of the groundwater remedy. Data collected during the RI showed that there was no deeper soil contamination beneath the smear zone. Thus, there are no COCs for deep soils at WP14.

**Summary**

Actual or threatened releases of hazardous substances from WP14, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment.

## 2.4 Remedial Action Objectives, Alternatives, and Comparative Analysis for WP14

The following subsections discuss the remedial action objectives for WP14, and present a description of the various alternatives which were evaluated to achieve those remedial objectives. The results of the detailed comparison made between those alternatives are also presented.

### 2.4.1 Remedial Action Objectives

Specific remediation alternatives were developed and evaluated for the areas with potential risk and for the areas that exceeded the preliminary remediation goals identified in Section 2.3.3. As previously discussed, the soil at WP14 does not have any COCs; therefore, RAOs were not developed for WP14 soils. The specific remedial action objective (RAO) for groundwater at WP14 is as follows:

- Prevent the ingestion, dermal contact, and inhalation of vapors from water from the groundwater having benzene, ethylbenzene, and toluene in excess of MCLs and/or resulting in a cancer risk greater than 1.0E-06 or Hazard Index greater than 1.0.

### 2.4.2 Groundwater Alternatives

As discussed in Section 2.3.3, the primary COCs for WP14 are fuel constituents in groundwater. The four most promising groundwater alternatives ("G") were chosen on the basis of the nine CERCLA criteria. These included no action (G1); long-term monitoring with institutional controls and product recovery (G2); pump and treat with institutional controls and long-term monitoring (G3); and high-vacuum extraction with institutional controls and long-term monitoring (G4). In addition to addressing the contamination at WP14, these alternatives would also address the bluff groundwater at LF04 South (see Section 3.3). The COCs for LF04 South include fuel constituents and halogenated volatile organic compounds (HVOCs).

Time to complete cleanup for biological alternatives was calculated using a two-dimensional fate and transport model which considers biodegradation, retardation, advection, dispersion, and adsorption/desorption. Cleanup times for each alternative are presented in the discussion below. This model did not consider soil contamination as a continuing source of contamination to groundwater, but it did consider retardation caused by contaminants adhering to soil particles. Degradation rates were used to estimate the remediation time for fuel-contaminated smear zone soils. This time was factored into the groundwater remediation times.

Except for the no action alternative, the cost of each alternative includes monitoring of groundwater for the estimated time period to complete cleanup, up to a maximum of 30 years, in accordance with CERCLA guidance. Net present value cost was calculated using a 5% discount rate. Costs estimates were calculated using the USAF Remedial Action Cost Engineering and Requirement (RACER) system and have an accuracy of -30 to +50 percent.

The alternatives are as follows:

**Alternative G1: No Action**
There are no costs associated with this alternative.

Evaluation of this alternative is required by CERCLA as a baseline reflecting current conditions without any cleanup. This alternative is used for comparison with each of the other alternatives. It does not take into consideration future events such as degradation and dispersion; however, these processes are expected to occur. As a result, cleanup levels are expected to be achieved within the same time frame as Alternative G2 (14 years for WP14/LF04 South). This alternative does not include long-term monitoring, controls, or access restrictions; therefore, potential exposure pathways would not be eliminated and future degradation would not be monitored.

**Alternatives G2: Long-term Monitoring with Institutional Controls and Product Recovery**
Costs and time to cleanup for this alternative are presented in Table 2.4-1.

Groundwater would be remediated by natural processes (physical, chemical, and biological) that reduce contaminant concentrations. Data have shown the presence of some dissolved oxygen and nutrients in the groundwater beneath Elmendorf AFB; therefore, the assumption of biodegradation of COCs is reasonable. This alternative includes semi-annual sampling of the groundwater until cleanup levels are attained. Contaminants should degrade to regulatory levels within 14 years. Additionally, free phase floating product would be removed with a bailer during the semi-annual sampling events. Free-phase product is expected to be found in insignificant amounts and should not affect cleanup rates. Existing land use restrictions would be used to limit access to contaminated groundwater. Land use restrictions are part of the Base Comprehensive Plan. These controls would prohibit construction of groundwater wells for residential, industrial, or agricultural purposes in the contaminated shallow aquifer. The USAF would continue to monitor groundwater quality semi-annually until containment levels are below cleanup levels for two consecutive monitoring events. If there is any indication that cleanup levels will not be attained, the remedial actions would be reevaluated and additional action taken if necessary.

**Table 2.4-1**

**Costs and Time to Cleanup for Groundwater Alternatives at WP14/LF04 South Elmendorf AFB, AK**

| Alternative | Costs (Thousands of $) | | | Time to Cleanup (years) |
|---|---|---|---|---|
| | Capital | Annual O&M [a] | Present Value [b] | |
| G2 | 1.71 | 46.5 | 462 | 14 |
| G3 | 4620 | 257 | 7170 | 14 |
| G4 | 2940 | 155 | 3150 | 1.4 |

[a] O&M = Operation and maintenance
[b] Present value discount rate = 5%

**Alternative G3: Pump and Treat with Institutional Controls and Long-term Monitoring**

Costs and time to cleanup for this alternative are presented in Table 2.4-1. The groundwater model used to calculate remediation time factors in degradation and dispersion of contaminants as they migrate from the upgradient end of the plume to the extraction wells. The remediation times for Alternatives G2 and G3 are identical because the contamination furthest upgradient from the extraction wells will degrade and disperse before reaching the extraction wells.

In Alternative G3, groundwater extraction wells would be installed along the top of the bluff to remove contaminated groundwater and free product as it traveled towards Knik Arm. Extracted liquids would be piped to an oil/water separator where product would be separated from water. The recovered product would be disposed of at the Defense Reutilization and Marketing Office (DRMO). The water would be piped to an air stripping tower where an air stream would be used to volatilize contaminants from the liquid to the vapor phase. The vapor phase would be discharged to the atmosphere. The partially treated groundwater would be sent to a carbon adsorption system for additional treatment. The treated groundwater would then be discharged to Knik Arm. This alternative also includes land use restrictions and the monitoring program described in Alternative G2. When two consecutive monitoring events indicate that contaminant levels are below cleanup levels, the pump and treat system would be turned off. Semi-annual sampling would continue for one more year. The sample results would be evaluated to determine if the contaminant concentrations had stayed below cleanup levels. If so, the treatment system would be discontinued and no further action would be required. If contamination concentrations had rebounded, the treatment system would be restarted.

**Alternative G4: High-vacuum Extraction with Institutional Controls and Long-term Monitoring**

Costs and time to cleanup for this alternative are presented in Table 2.4-1.

In this alternative, extraction wells would be installed about 75 feet apart throughout the entire affected area. High vacuum (about 20 to 28 inches of mercury) would be applied to these wells to extract groundwater, floating product, and soil vapor at a fast rate. Reduced pressure and turbulence in the extraction wells would cause some contaminants to volatilize into the vapor phase as the water is extracted. The vapor phase would be discharged to the atmosphere. The liquid phase would flow to an oil/water separator. Recovered hydrocarbons would be sent to the DRMO. The groundwater would then be piped to a carbon adsorption unit for polishing before being discharged to Knik Arm. This alternative also includes land use restrictions and the monitoring program described in Alternative G2. When two consecutive monitoring events indicate that contaminant levels are below cleanup levels, the high-vacuum extraction system would be turned off. Semi-annual sampling would continue for one more year. The sample results would be evaluated to determine if the contaminant concentrations had stayed below cleanup levels. If so, the treatment system would be discontinued and no further action would be required. If contamination concentrations had rebounded, the treatment system would be restarted.

### 2.4.3 Summary of Comparative Analysis of Groundwater Alternatives

The comparative analysis describes how each of the groundwater alternatives meet the CERCLA evaluation criteria relative to each other.

**Threshold Criteria**

Threshold criteria are those that must be met for the alternative to be viable and relate directly to the statutory determinations discussed in Section 2.5.1. This category includes two criteria: overall protection of human health and the environment and compliance with ARARs.

**Overall Protection of Human Health and the Environment**--Alternatives G2, G3, and G4 all meet this criterion since they each monitor the reduction of contaminants to acceptable levels through active treatment or natural processes. Alternative G4 is considered to provide the most protection (primarily by virtue of its comparatively short remediation time, 1.4 years), followed by Alternatives G2 and G3 (14 years). Alternative G1 (No Action) was the only alternative that failed to meet this criterion. This failure was a result of the alternative not satisfying the RAOs nor complying with ARARs. This alternative is therefore the least protective.

**Compliance with ARARs**--Alternatives G2, G3, and G4 each meet this criterion for chemical-specific ARARs since each provide for the timely reduction of groundwater contaminants to levels below ARARs. Alternative G4 would comply with chemical-specific ARARs sooner than the other alternatives and is therefore considered the most compliant of the alternatives. Alternatives G2 and G3 would take longer to remediate in-situ contamination concentrations down to drinking water standards (i.e., MCLs). Alternatives G3 and G4 are preferred because they comply with ARARs through active treatment of the groundwater. Alternative G1 (No Action) failed to meet this criterion because it does not include a sampling program which would monitor contaminant concentrations in the future. Therefore, it would not be known if and when contaminant concentrations attenuated to drinking water standards (i.e., MCLs). Alternatives G2, G3, and G4 all contained a sampling program that would monitor future concentrations.

No location-specific ARARs were identified for this site; therefore, there is no difference among the alternatives with regards to these ARARs.

Action-specific ARARs would be satisfied for each of the alternatives, so Alternatives G1, G2, G3, and G4 each meet this criterion for action-specific ARARs. There are no action-specific ARARs associated with Alternatives G1 and G2, making them preferable to Alternatives G3 and G4. Both Alternatives G3 and G4 would involve complying with the federal and state wastewater discharge regulations. Compliance should be readily achieved, but would require more effort than Alternatives G1 and G2.

**Balancing Criteria**

Balancing criteria are the primary basis for comparing alternatives. These criteria relate the alternative to the site-specific conditions. The no action alternative (G1) is not evaluated based on the balancing criteria or the modifying criteria, since it did not meet both threshold criteria. Balancing criteria includes long-term effectiveness and permanence; reduction in toxicity, mobility, and volume through treatment; short-term effectiveness; implementability; and cost.

**Long-term Effectiveness and Permanence**--This criterion has to do with long-term protection of human health and the environment (reduction of risks), and adequacy and reliability of controls. Long-term management ("controls") would include a 5-year review, land use restrictions, and annual groundwater monitoring. Alternatives G2, G3, and G4 each fully met this criterion, since each alternative includes effective long-term management and permanent reduction of risks through the elimination of contamination. The monitoring requirements and ability to reduce the risk to within established health guidelines are similar for all three alternatives.

**Reduction in Toxicity, Mobility, and Volume Through Treatment**--Alternatives G3 and G4 fully meet this criterion since both include active treatment processes to remediate groundwater contaminants. Both provide an active treatment technology that would reduce the toxicity, mobility, and volume of contaminated media. For these two alternatives, there is little, if any, difference in the amounts of contaminants irreversibly destroyed or treated, and the type and quantity of residuals remaining after treatment. Alternative G2 does not satisfy this criterion because it does not include active treatment. Instead, it relies solely on naturally occurring processes to reduce the toxicity and volume of the contamination; the mobility of the contamination would not be changed in this alternative.

**Short-term Effectiveness**--This criterion evaluates risks to workers, the community, and the environment during the period of time until remedial action objectives are met. Alternatives G2, G3, and G4 each meet this criterion since each provide adequate protection and risk reduction while groundwater contaminants are being reduced to acceptable levels. Alternative G4 is considered the most effective in the short term because its remediation time of 1.4 years is substantially less than the 14 years anticipated for Alternatives G2 and G3. Alternatives G3 and G4 involve some risks to the workers and the community during the construction and operation of remedial equipment. However, these risks are considered minor and very manageable. Alternative G2 does not pose these risks to workers or the community.

**Implementability**--Each of the alternatives is considered fully implementable at WP14, therefore G2, G3, and G4 each fully meet this criterion. Alternative G2 is considered the most implementable, followed by Alternatives G4 and G3, respectively. Alternative G2 would not require the construction or operation of remedial equipment. However, it relies upon the least reliable technology. The calculated rate of degradation and dispersion has substantial uncertainties. Nevertheless, Alternative G2 is the most practical alternative for WP14/LF04 South, because of the wide-spread plume in a non-homogeneous aquifer and the arduous and unstable topography that makes installation of an active treatment system difficult and costly. The LF04 bluff is eroding; therefore, although the active treatment alternatives are implementable, it is impractical to construct such a system at WP14/LF04 South. In terms of the reliability of the technologies, Alternative G3 uses conventional pump-and-treat methods which have historically had difficulties in achieving drinking water standards particularly in locations where contamination is wide spread and resides in a non-homogeneous aquifer. Although Alternative G4 uses an innovative technology, it is not significantly less reliable than Alternative G3, primarily because Alternative G4 is considered to have a higher probability of being able to achieve drinking water standards.

**Cost**--Alternative G1 does not have any costs associated with it. At WP14/LF04 South, the next least expensive alternative is G2 ($462K), followed by G4 ($3,150K) and G3 ($7,170K). All costs are in present value.

**Modifying Criteria**

Modifying criteria consider state and community concerns.

**State Acceptance**--The State of Alaska has been involved in the development of alternatives for WP14/LF04 South and concurs with the USAF and the USEPA in the selection of Alternative G2, long-term monitoring with institutional controls and product removal, for groundwater at WP14/LF04 South. The Air Force will investigate and implement other remedial alternatives should the selected remedy prove to be unsuccessful at meeting the required cleanup levels.

**Community Acceptance**--All of the alternatives were presented to the public in the Proposed Plan. Based on the comments received during the public comment period, the public has no preference of alternatives.

### 2.4.4 Soil Alternatives

Soil alternatives are developed to meet the RAOs. As discussed in Section 2.3.3 and 2.4.1, the soils at WP14 do not have any COCs or RAOs; therefore, alternatives were not developed for the WP14 soils. The FS and Proposed Plan listed alternatives for soils, but information developed since then has shown that soils at WP14 do not contain constituents above cleanup levels. This eliminated the need for further consideration of soil alternatives in this ROD.

### 2.4.5 Summary of Comparative Analysis of Soil Alternatives

The comparative analysis describes how each of the soil alternatives meet the CERCLA evaluation criteria relative to each other. Alternatives were not developed for the WP14 soils. Consequently, a comparative analysis of soil alternatives was not conducted.

## 2.5 Selected Remedy for WP14

The selected remedy for WP14 includes Alternative G2 (long-term monitoring with institutional controls and product removal) for the groundwater and no further action for the soils. This remedy best meets the nine CERCLA criteria. It protects human health and the environment, and complies with ARARs. It is effective at reducing contamination both in the short term and long term, and is implementable, cost-effective, and acceptable to the public and the State of Alaska. This alternative reduces risks and complies with ARARs. Modeling showed that cleanup can occur within a reasonable time (14 years of monitoring for groundwater). The known sources of contamination have been controlled, so they are no longer a threat. This remedy will naturally degrade the residual contamination.

Alternative G2 was selected because it best provides the following specific benefits at WP14:

- Institutional controls will prevent exposure to contaminated groundwater until cleanup levels are met.
- Alternative G2 is the most cost-effective groundwater alternative.
- The selected alternative does not require construction near the LF04 bluff; therefore, slope stability will not be a problem.

Specific components of the selected remedy are illustrated in Figure 2.5-1 and consist of the following:

**Groundwater at WP14:**

- Institutional controls on land use and water use, as specified in the Base Comprehensive Plan, will restrict access to the contaminated groundwater throughout WP14. Installation of wells in the contaminated plume for residential, industrial, and agricultural use will be prohibited by the Base Comprehensive Plan until cleanup levels have been achieved.
- Groundwater will be monitored semi-annually and evaluated annually to determine contaminant migration and to track the progress of contaminant degradation and dispersion, as well as to provide an early indication of unforseen environmental or human health risk. Five-year reviews will also assess the protectiveness of the remedial action, including an evaluation of any changed site conditions, as long as contamination remains above cleanup levels.
- Recoverable quantities of free product found on top of the water table at WP14 will be regularly removed during groundwater monitoring events.
- Groundwater monitoring will be discontinued if contaminant levels are below cleanup levels during two consecutive monitoring events. In that case, no further action for groundwater will be required.
- During the final round of monitoring, samples will be collected and analyzed for all constituents that exceeded MCLs during the 1994 investigation including VOCs, SVOCs, and metals. These results will be evaluated before a final determination is made that groundwater meets all cleanup requirements.
- All groundwater is expected to be cleaned up within 14 years.

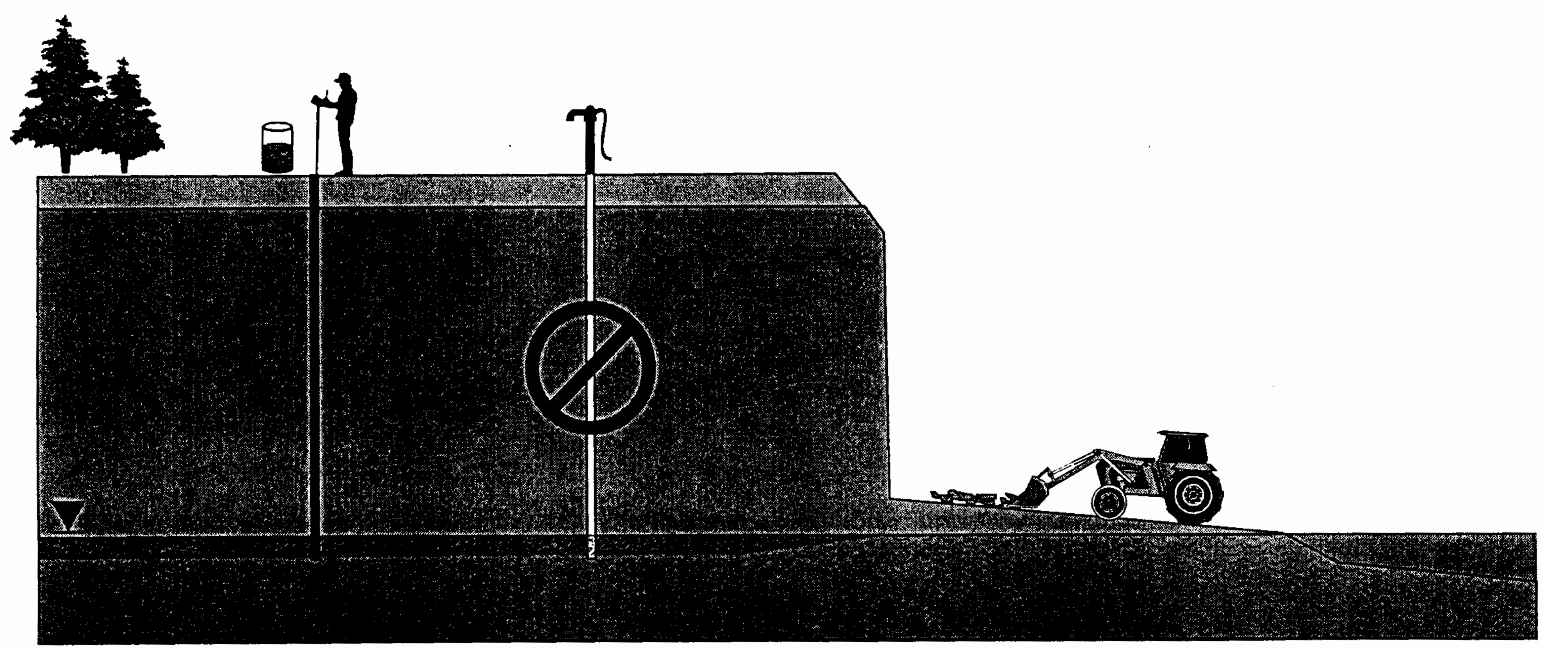


Figure 2.5-1. Selected Alternatives for WP14 and LF04

**Soil at WP14:**

- No further action will be required for the soil at WP14.

The estimated time for groundwater cleanup is 14 years. Groundwater will be monitored to evaluate the progress of degradation and dispersion. Further response actions, coordinated with the regulatory agencies, may be considered if monitoring finds unacceptable contaminant migration or unacceptable reduction in contaminant concentrations.

Because the remedy will result in contaminants remaining on-site above health based levels, a review will be conducted within 5 years after commencement of remedial action. The review will ensure that the remedy continues to provide adequate protection of human health and the environment. The cleanup levels to be achieved (i.e., remediation goals) through the selected remedy for COCs at WP14 are presented in Table 2.5-1.

The selected remedy includes provisions for the preparation of a workplan for continued environmental monitoring of the affected media. The workplan will include specific details regarding the number and location of monitoring points, as well as guidelines for eliminating select monitoring points as cleanup occurs. Environmental monitoring will be discontinued at WP14 when the remediation goals have been satisfactorily achieved (Table 2.5-1). This determination will be made jointly by the USAF, the USEPA, and the State of Alaska pursuant to the Federal Facility Agreement.

### 2.5.1 Statutory Determinations

The selected remedy satisfies the requirements under Section 121 of CERCLA to:

- Protect human health and the environment;
- Comply with ARARs;
- Be cost effective; and
- Utilize permanent solutions and alternative treatment technologies to the maximum extent practicable.

**Protective of Human Health and the Environment**

The selected remedy is protective of human health and the environment. There are no current points of exposure; therefore, risks are low. Institutional controls will protect against potential risk by assuring that the contaminated groundwater will not come in contact with people until RAOs have been met.

Risks were calculated using assumptions regarding exposure pathways and the time receptors were exposed to the contaminants. Each exposure was estimated conservatively in a manner which tends to overestimate the actual risk. Risk management decisions were made considering the uncertainty in the assumptions used in the risk assessment. At WP14, the shallow groundwater is not used and is not expected to be used in the future, so existing risks and potential risks are significantly less than the worst-case risk.

There are no direct current receptors of groundwater at WP14. Institutional controls will protect against the potential risk to human health by ensuring that contaminated shallow aquifer

## Table 2.5-1

## Identification of Chemical-Specific ARARs and Remediation Goals, WP14/LF04 South Elmendorf AFB, AK

| Location | Chemical | Maximum Concentration | Remdiation Goal | Basis for Remediation Goal[1] |
|---|---|---|---|---|
| **Groundwater:** | | | | |
| WP14 | Benzene | 1390 μg/L | 5 μg/L | MCL |
| | Ethylbenzene | 1410 μg/L | 700 μg/L | MCL |
| | Toluene | 3190 μg/L | 1000 μg/L | MCL |
| LF04 South | Benzene | 3400 μg/L | 5 μg/L | MCL |
| | Ethylbenzene | 722 μg/L | 700 μg/L | MCL |
| | Toluene | 3020 μg/L | 1000 μg/L | MCL |
| | 1,2-Dichloroethane | 32.6 μg/L | 5 μg/L | MCL |
| | Methylene chloride | 6.53 μg/L | 5 μg/L | MCL |

[1] Maximum Contaminant Level (MCL); 40 CFR § 141.61 for Federal MCLs, and 18 AAC 80.070 for State MCLs. Federal and State MCLs are identical for the COCs.

groundwater will not be consumed by people until cleanup levels (MCLs) are met. The time required to achieve MCLs is not known, but could be as short as 14 years based upon groundwater modeling results. Modeling of contaminant flow at Elmendorf AFB showed that conditions are not expected to deteriorate at WP14. Modeling predicts that, over time, cleanup objectives will be met by degradation.

**Applicable or Relevant and Appropriate Requirements (ARARs)**

**Chemical-Specific ARARs** -- Chemical-specific cleanup levels (i.e., remediation goals) for OU 6 are identified in Table 2.5-1. The Maximum Contaminant Levels (MCLs) established for drinking water under State and Federal laws are relevant and appropriate to groundwater contaminants of concern at WP14 as a chemical-specific regulation. Semi-annual groundwater monitoring will document compliance with MCLs.

**Location-Specific ARARs** -- There are no specific ARARs which must be met because of the location of the contamination and remedial actions at WP14.

**Action-Specific ARARs** --There are no action-specific ARARs for the selected remedy at WP14.

**Cost Effectiveness**

The selected remedy is the most cost effective of the alternatives because it affords overall effectiveness proportional to its costs.

**Utilization of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable**

The USAF and the USEPA have determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be used in a cost-effective manner at WP14. Of those alternatives that are protective of human health and the environment and comply with ARARs, the USAF and the USEPA have determined that the selected remedy provides the best balance of tradeoffs in terms of long-term effectiveness and permanence; reduction in toxicity, mobility, or volume achieved through treatment; short-term effectiveness; implementability; cost (as discussed in the preceding section); the statutory preference for treatment as a principal element; and considering State and community acceptance. The selected remedy will permanently remove the contaminants through natural, biological break down of the contaminants into harmless chemical compounds. The State of Alaska concurs with these determinations.

**Preference for Treatment as a Principal Element**

Because of the substantial cost of actively treating groundwater, the potential for natural degradation in 14 years, and the fact that there are no current receptors of groundwater, long-term monitoring with institutional controls and product recovery is a more favorable means of addressing groundwater contamination than active treatment.

### 2.5.2 Documentation of Significant Changes

The Proposed Plan listed soil and groundwater constituents with concentrations in excess of cleanup goals (ACM guidelines and MCLs). COCs were then identified in Section 2.3.3 by evaluating whether a constituent exceeded regulatory levels and/or contributed to risk. Mitigating circumstances were also evaluated when establishing COCs including sampling techniques and whether the contamination was in the smear zone. Thus, the list of contaminants exceeding cleanup levels in the Proposed Plan was not the same as the list of COCs defined in the ROD.

The selected remedy for groundwater at WP14 was the preferred alternative presented in the Proposed Plan (Table 7 of the Proposed Plan). No significant changes were made to this alternative.

One significant change from the Proposed Plan was the use of ACM Level C as opposed to Level B for soils at WP14. This change occurred while re-examining the ACM scoring criteria during the preparation of the ROD. Consensus was reached between ADEC, USEPA, and USAF that the ACM Level C guidelines is more appropriate for the site conditions at WP14. As a result, no COCs were established for shallow soils at WP14 and no further action is necessary. Thus, the preferred alternative in the Proposed Plan (Excavation, Thermal Treatment, and Backfilling) is not the same as the selected remedy (No Further Action).

The selected remedy for deep soils also changed. A treatability study at WP14 indicated that deep soil contamination was actually smear zone contamination; therefore, as discussed in Section 2.3.3, no COCs were established for deep soils. The preferred alternative in the Proposed Plan was Bioventing. This was changed to No Further Action for the selected remedy. All changes are a logical outgrowth of the Proposed Plan.

# SECTION THREE

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# Section 3.0
# SOURCE LF04

The following subsections describe the physical description, land use, groundwater use, and hydrogeology of LF04. The identification of activities which led to the current contamination at LF04 is also included. The discussion of the regulatory and enforcement history of LF04, the role of the response action at LF04, and community participation in the response action are included in the general OU 6 discussion in Section 1.0. The detailed discussion of the hydrogeology at LF04 was combined with the description of the hydrogeology at WP14, and is presented in Section 2.1.2. These discussions were combined because of the close proximity between Sources LF04 and WP14 on the Elmendorf Moraine.

## 3.1 Site Description

Source LF04 is a landfill located east of Knik Arm Bluff on the west side of Elmendorf AFB (Figure 1.1-2). As indicated by its name, the Knik Bluff Landfill (LF04) coincides mostly with the presence of a steep bluff which drops from an elevation in excess of 200 feet down to sea level. The landfill parallels Knik Arm for a distance of approximately 3000 feet and is approximately 600 feet wide (Figure 3.1-1). Along the southern end of the landfill, the ground surface slopes toward Knik Arm and the bluff is less pronounced.

LF04 was used as a surface dump from 1945 to 1957. Debris appears to have been dumped directly off of the bluff, or used as a means of filling ravines in the side of the bluff. Old cars, construction rubble, and small quantities of general refuse have been dumped at the landfill, in addition to an unknown number of 55-gallon drums. Debris from the landfill has drifted downslope onto the beach over time. Observations made from this beach suggest that the landfill material was also burned in place. Tidal action appears to be eroding the bluff material and increasingly exposing portions of the landfill. Several groundwater seeps occur on the Knik Arm Bluff or at the beach.

Active and abandoned POL lines cross the southern extent of LF04. A pumphouse serving the lines (Building 30-790) is also located at the south end of the site.

### 3.1.1 Land Use

LF04 is currently designated as a "restricted use area" in the Base Comprehensive Plan. This designation provides for recreational use of the parcel (cross country skiing, etc.) and for construction of unmanned facilities such as a parking lot, storage building, or taxiway, but prohibits the construction of any sort of manned facility such as an office building or a residence. Drilling into the shallow aquifer is also restricted by the Base Comprehensive Plan. As a former landfill, LF04 will maintain this designation indefinitely.

There are no known historic buildings, archeological sites, wetlands, floodplains, or rare or endangered species at LF04.

### 3.1.2 Hydrogeology and Groundwater Use

The discussion of the hydrogeologic setting for sources LF04 and WP14 have been combined because of their close proximity on the Elmendorf Moraine. That discussion is found in Section 2.1.2 of this document. For a more general description of Elmendorf AFB geology and hydrogeology, the reader is referred to Section 1.1, or to the OU 6 Remedial Investigation/Feasibility Report (USAF, 1996b).

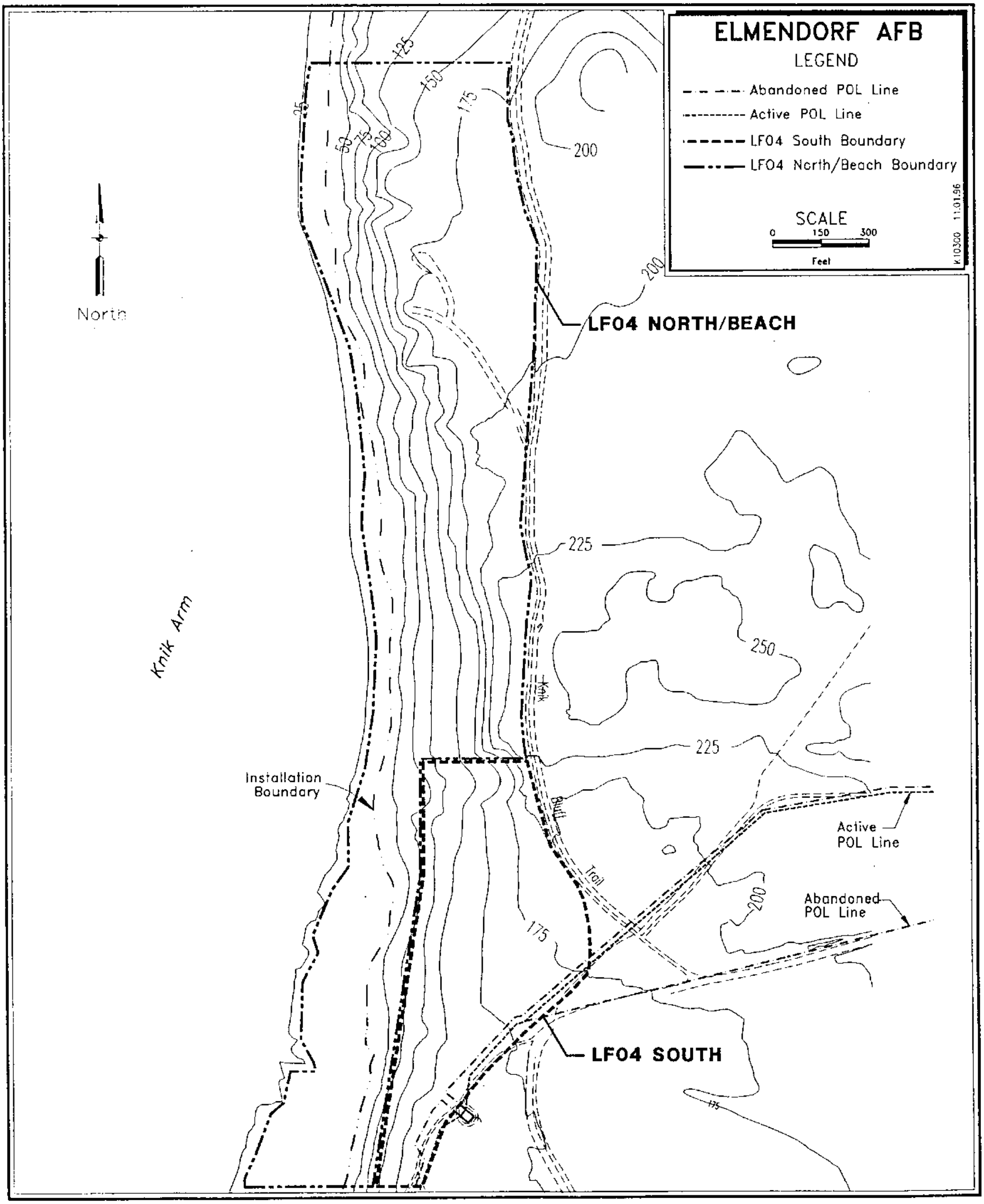


**Figure 3.1-1. Location Map for Source Area LF04**



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In general, three aquifers were detected during the course of the RI at LF04 and WP14. All three aquifers are believed to vertically communicate. The aquifers are primarily silty sands occurring as perched lenses within the morainal deposits on the bluff. The lowermost aquifer is near the level of the beach. Substantial fine-grained, clayey materials near this interval are believed to coincide with the top of the Bootlegger Cove Clay.

Groundwater flow is generally to the west, towards the Knik Arm. A generalized hydrogeologic conceptual model for this area is presented in Section 2.1 as Figure 2.1-2. The estimated hydraulic conductivity for this area ranges from 1.12E-3 to 3.59E-5 cm/sec in the various perched aquifers.

The groundwater in the regional shallow aquifer on base, which is believed to correspond roughly with the third aquifer at the beach at LF04, is not used for any purpose. Its future use, even if the aquifer was uncontaminated, is generally limited because of the higher yield of the deeper confined aquifer which underlies the Bootlegger Cove Clay. In the vicinity of LF04, the fine-grained nature of the perched aquifer material, and the laterally discontinuous nature of the perched aquifer lenses, would make these perched aquifers unsuitable as drinking water supply aquifers. In addition, the instability of the bluff slope at LF04 makes it highly unlikely that the area could ever be used residentially.

## 3.2 Site History and Enforcement Activities

The following section identifies the activities which lead to the current contamination at LF04. The regulatory and enforcement history for LF04 is included in the general discussion presented for OU 6 in Section 1.0, as are the discussions of the role of the response action and the community participation in the response.

### 3.2.1 Identification of Activities Leading to the Current Contamination at LF04

Soil contaminants detected at LF04 include pesticides, dioxins and furans, metals, PCBs, and fuel-related constituents. Similar contaminants were identified in the groundwater, as well as halogenated volatile organic compounds (HVOCs).

There are several principal sources of contamination at Source LF04, including waste management practices, leaking POL facilities, and migration from upgradient sources. Due to the landfilling activities conducted at LF04, it is likely that contaminants from each of the groups mentioned above were made available to contaminate the soil and groundwater. The elevated concentrations of inorganic constituents detected during this investigation most likely indicate that materials containing heavy metals (such as automotive and aviation batteries) have been dumped over the edge of the bluff. Drums previously observed on the ground surface on the bluff also constitute a potential contaminant source at LF04, and may be responsible for the low levels of solvents or fuels detected in soil and groundwater samples in the area. Old transformers act as a source of polychlorinated biphenyls (PCBs); various metallic wastes act as the metals source, etc. Pesticides were also prevalent at LF04. Based on the extreme heterogeneity of occurrences of pesticides, and heavy occurrences primarily adjacent to access roads, the pesticide contamination is believed to be the result of incidental disposal of residual pesticides in the course of pesticide application events.

At the southern end of LF04, a pumphouse and various fuel lines and valve pits act as a second principal contaminant source for fuel-related constituents. Probable evidence of leakage from the POL facilities at LF04 was observed during the RI.

Groundwater migration from WP14 and/or other upgradient sources comprise another source of contamination for LF04. As described in Section 3.1.2, groundwater is present in several aquifers within the LF04/WP14 area, and substantial vertical and lateral mixing between these aquifers allows the downgradient spread of dissolved phase contaminants across this site. Downward percolation of groundwater through contaminated soils at LF04 can also act as a contaminant source for the shallow aquifer. Seasonal fluctuations in the water table have resulted in a smear zone being detected at the base of the vadose zone within LF04. A schematic of the potential migration and exposure pathways for fuels and solvents through the soil and into the groundwater is presented in Section 2.2.1, Figure 2.1-1, for Sources WP14 and LF04.

Prior to the RI conducted at LF04 in 1994, LF04 had been addressed under the following studies:

- IRP Phase I/II Records Search and Statement of Work (Engineering-Science, 1983);
- IRP Phase II Remedial Investigation (JMM/Harza Environmental, 1988);
- IRP Phase II Stage 3 Work Plan (Harding Lawson, 1988); and
- RCRA Facility Assessment Report (ADEC, 1988).

Landfilling practices at the LF04 Knik Bluff Landfill ceased in 1957. The pumphouse serving the active and abandoned lines (Building 30-790) has been taken out of service. The active POL line at LF04 has been tested and determined to be sound. The abandoned line was reportedly drained of fuel and abandoned in sections in place. Buried tanks which serviced the pumphouse were removed in 1996.

## 3.3 Site Contamination, Risks, and Areas Requiring Response Actions

This section identifies the areas which were investigated, and those that require remedial action. These areas were chosen based on the risk that contaminants pose to human health and the environment. The basis of this analysis is the data collected during the Remedial Investigation (RI) which identified the nature and extent of contamination at LF04.

### 3.3.1 Nature and Extent of Contamination

During the RI, samples of soil and groundwater were collected and analyzed for organic and inorganic constituents. Potentially significant levels of organic contaminants were detected in both the soil and groundwater at LF04. These contaminants include fuels and fuel constituents, solvents, metals, pesticides, semi-volatile organic compounds, and dioxins. The contamination present at LF04 is associated with contaminant transport in the vadose zone, dissolved aqueous transport, and volatilization, as well as surface water flow at the seeps. These transport mechanisms are pictorially represented for LF04 in Figure 2.2-1.

Tables 3.3-1 through 3.3-5 list the frequency of occurrence and maximum concentrations of all constituents which were detected during the RI in groundwater and soil. The tables do not include results below the detection limit. The MCLs for groundwater and the ACM guidelines for soil are also listed on the tables for all constituents. Results are separated between "indicator parameters" and "contaminant parameters."

## Table 3.3-1

### Summary of Groundwater Analytical Results for Bluff Area at Source LF04
### Elmendorf AFB, AK

| Method (units) | Analyte | MCL[1] | Maximum Result | Frequency of Detections Total Hits/ Total Samples | Location of Maximum Result |
|---|---|---|---|---|---|
| **Indicator Parameters** | | | | | |
| SW6010, Total (mg/L) | Aluminum | -- | 100 | 14/14 | K-302 |
| | Calcium | -- | 182 | 14/14 | K-302 |
| | Iron | -- | 146 | 14/14 | K-302 |
| | Magnesium | -- | 67.7 | 14/14 | K-302 |
| | Potassium | -- | 8.54 | 13/14 | K-302 |
| | Sodium | -- | 15 | 14/14 | K-302 |
| SW6010, Dissolved (mg/L) | Aluminum | -- | 0.275 | 4/7 | MW-61 |
| | Calcium | -- | 99.2 | 7/7 | MW-61 |
| | Iron | -- | 15.6 | 7/7 | MW-74 |
| | Magnesium | -- | 34.7 | 7/7 | MW-61 |
| | Potassium | -- | 2.75 | 7/7 | MW-61 |
| | Sodium | -- | 13.2 | 7/7 | MW-67 |
| **Contaminant Parameters** | | | | | |
| SW8260 (µg/L) | Acetone | -- | 27.1 b | 10/14 | MW-67 |
| | Benzene | 5 | 3400 | 14/14 | MW-61 |
| | 2-Butanone(MEK) | -- | 32.4 b | 7/14 | MW-61 |
| | Chloroethane | -- | 0.83 | 3/14 | MW-61 |
| | Chloroform | 100 | 1.25 | 2/14 | MW-67 |
| | Chloromethane | -- | 3.72 | 10/14 | K-302 |
| | 1,2-Dichlorobenzene | 600 | 0.6 | 1/14 | MW-77 |
| | 1,1-Dichloroethane | -- | 2.05 | 1/14 | MW-77 |
| | 1,2-Dichloroethane | 5 | 38.7 b | 7/14 | MW-61 |
| | cis-1,2-Dichloroethene | 70 | 20 | 3/14 | MW-77 |
| | 1,2-Dichloropropane | 5 | 0.31 | 1/14 | MW-61 |
| | Ethylbenzene | 700 | 722 | 13/14 | MW-77 |
| | Methylene chloride | 5 | 290 b | 10/14 | MW-67 |
| | 4-Methyl-2-pentanone(MIBK) | -- | 8.95 | 4/14 | MW-61 |
| | Toluene | 1000 | 3020 | 14/14 | MW-77 |
| | 1,1,1-Trichlorethane | 200 | 0.19 B | 1/14 | MW-77 |
| | Trichloroethene | 5 | 0.47 | 2/14 | MW-77 |
| | Vinyl chloride | 2 | 0.8 | 1/14 | MW-61 |
| | m&p-Xylene | -- | 1640 | 13/14 | MW-77 |
| | o-Xylene | -- | 498 | 12/14 | MW-77 |
| SW8080 (µg/L) | Aldrin | -- | 0.0171 | 5/14 | K-302 |
| | alpha-BHC | -- | 0.0197 | 6/14 | MW-77 |
| | beta-BHC | -- | 0.0688 | 1/14 | MW-78 |
| | gamma-BHC(Lindane) | 0.2 | 0.0447 | 11/14 | MW-77 |
| | 4,4'-DDD | -- | 0.023 | 1/14 | MW-61 |
| | 4,4'-DDE | -- | 0.0179 | 1/14 | MW-61 |



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## Table 3.3-1

## (Continued)

| Method (units) | Analyte | MCL[1] | Maximum Result | Frequency of Detections Total Hits/ Total Samples | Location of Maximum Result |
|---|---|---|---|---|---|
| SW8080 (μg/L) (continued) | 4,4'-DDT | -- | 0.028 | 2/14 | MW-61 |
| | Dieldrin | -- | 0.0128 | 6/14 | MW-61 |
| | Endosulfan I | -- | 0.0087 | 2/14 | K-302 |
| | Endrin Aldehyde | -- | 0.0327 | 1/14 | MW-61 |
| | Heptachlor | -- | 0.0177 | 5/14 | K-302 |
| | Heptachlor epoxide | -- | 0.0121 PB | 10/14 | K-302 |
| SW8270 (μg/L) | Benzoic acid | -- | 26.3 | 2/14 | MW-77 |
| | 2,4-Dimethylphenol | -- | 1.89 | 2/14 | MW-63 |
| | Diethylphthalate | 6 | 0.516 | 1/14 | K-302 |
| | Dimethylphthalate | -- | 41.3 | 4/14 | MW-77 |
| | bis(2-Ethylhexyl)phthalate | 6 | 24.2 | 1/14 | MW-61 |
| | 2-Methylnaphthalene | -- | 63.1 | 8/14 | MW-77 |
| | 2-Methylphenol (o-cresol) | -- | 5.64 | 2/14 | MW-77 |
| | 4-Methylphenol/ 3-Methylphenol | -- | 31.7 F | 4/14 | MW-77 |
| | Phenol | -- | 88.3 | 5/14 | MW-61 |
| SW8310 (μg/L) | Acenaphthene | -- | 20.3 | 8/14 | MW-67 |
| | Acenaphthylene | -- | 2.25 | 2/14 | MW-77 |
| | Anthracene | -- | 0.34 | 1/14 | K-302 |
| | Benzo(b)fluoranthene | 0.2 | 0.0225 B | 1/14 | K-302 |
| | Chrysene | 0.2 | 0.14 | 1/14 | K-302 |
| | Fluorene | -- | 1.49 | 8/14 | MW-67 |
| | Naphthalene | -- | 122 B | 10/14 | MW-77 |
| | Phenanthrene | -- | 0.454 | 1/14 | MW-77 |
| SW6010, Total (mg/L) | Barium | 2 | 0.699 | 4/14 | K-302 |
| | Beryllium | 0.004 | 0.00193 B | 8/14 | K-302 |
| | Cadmium | 0.005 | 0.00628 | 1/14 | MW-61 |
| | Chromium | 0.1 | 0.149 | 5/14 | K-302 |
| | Cobalt | -- | 0.0688 | 7/14 | K-302 |
| | Copper | 1.3[2] | 0.345 | 4/14 | K-302 |
| | Manganese | -- | 20.8 | 14/14 | MW-77 |
| | Nickel | 0.1 | 0.243 | 5/14 | K-302 |
| | Selenium | 0.05 | 0.0911 | 1/14 | K-302 |
| | Vanadium | -- | 0.287 | 3/14 | K-302 |
| | Zinc | -- | 0.401 | 14/14 | K-302 |
| SW7060, Total (mg/L) | Arsenic | 0.05 | 0.0748 | 14/14 | K-302 |
| SW7421, Total (mg/L) | Lead | 0.015[2] | 0.0447 | 6/14 | K-302 |
| SW6010, Dissolved (mg/L) | Barium | 2 | 0.0669 | 7/7 | MW-61 |
| | Beryllium | 0.004 | 0.00129 B | 1/7 | MW-61 |
| | Cadmium | 0.005 | 0.00771 | 1/7 | MW-61 |
| | Chromium | 0.1 | 0.00538 | 1/7 | MW-67 |
| | Cobalt | -- | 0.00738 | 1/7 | MW-67 |

## Table 3.3-1

## (Continued)

| Method (units) | Analyte | MCL[1] | Maximum Result | Frequency of Detections Total Hits/ Total Samples | Location of Maximum Result |
|---|---|---|---|---|---|
| SW6010, Dissolved (mg/L) (continued) | Manganese | -- | 6.92 | 7/7 | MW-67 |
| | Zinc | -- | 0.017 B | 5/7 | MW-67 |
| SW7060, Dissolved (mg/L) | Arsenic | 0.05 | 0.029 | 7/7 | MW-67 |

[1] Maximum contaminant level (MCL); 40 CFR § 141.61 for Federal MCLs, and 18 AAC 80.070 for State MCLs. Federal and State MCLs are identical for the listed constituents.

[2] From 40 CFR, Section 141.11 for inorganics and Section 141.12 for organics (effective 1 July 1991); however, the lead level is effective only until 7 December 1992. There is no longer an MCL for lead or copper (56 Federal Register 26460, June 7, 1991); however, there is an action level of 0.015 mg/L for lead and 1.3 mg/L for copper.

b - Due to high concentrations of other target compounds in the sample, or to interference by non-target analytes, the sample could not be run at a dilution factor of one. The flagged analyte concentrations is less than the blank UTL times the sample dilution factor.

B - Sample concentration was less than or equal to the blank UTL.

F - Co-elution or interference was suspected.

P - Analyte quantitation not confirmed. Results from primary and secondary GC columns differ by greater than a factor of three.

## Table 3.3-2

### Summary of Groundwater Analytical Results for Beach Area at Source LF04 Elmendorf AFB, AK

| Method (units) | Analyte | MCL[1] | Maximum Result | Frequency of Detections Total Hits/ Total Samples | Location of Maximum Result |
|---|---|---|---|---|---|
| **Indicator Parameters** | | | | | |
| SW8015ME (µg/L) | Unidentified organics [UDRO] | -- | 840 | 11/13 | K-304 |
| SW8015MP (µg/L) | Unidentified organics [UGRO] | -- | 8700 | 12/13 | K-304 |
| | Xylene (total) | 10000 | 292 | 12/13[2] | MW-81 |
| SW6010, Total (mg/L) | Aluminum | -- | 23.3 | 12/13 | MW-85 |
| | Calcium | -- | 196 | 13/13 | MW-85 |
| | Iron | -- | 39.5 | 13/13 | MW-85 |
| | Magnesium | -- | 121 | 13/13 | MW-84 |
| | Potassium | -- | 16.2 | 13/13 | MW-83 |
| | Sodium | -- | 480 | 13/13 | MW-83 |
| SW6010, Dissolved (mg/L) | Aluminum | -- | 0.153 B | 2/5 | MW-84 |
| | Calcium | -- | 179 | 4/5 | MW-85 |
| | Iron | -- | 6.8 | 4/5 | MW-85 |
| | Magnesium | -- | 120 | 4/5 | MW-84 |
| | Potassium | -- | 15.6 | 4/5 | MW-83 |
| | Sodium | -- | 458 | 5/5 | MW-83 |
| **Contaminant Parameters** | | | | | |
| SW8015ME (µg/L) | Jet Fuel (JP-4) | -- | 903 | 2/13 | K-304 |
| SW8015MP (µg/L) | Gasoline | -- | 5160 | 1/13 | K-304 |
| SW8260 (µg/L) | Acetone | -- | 9.95 B | 13/13 | MW-84 |
| | Benzene | 5 | 5.8 | 9/13 | K-304 |
| | 2-Butanone(MEK) | -- | 2.18 B | 4/13 | MW-85 |
| | Chloroethane | -- | 0.12 B | 1/13 | MW-82 |
| | Chloroform | 100 | 0.2 | 2/13 | MW-82 |
| | Chloromethane | -- | 5.23 | 9/13[2] | MW-81 |
| | 1,2-Dichloroethane | 5 | 0.9 B | 2/13 | MW-84 |
| | cis-1,2-Dichloroethene | 70 | 8.28 | 5/13 | MW-82 |
| | trans-1,2-Dichloroethene | 100 | 5.17 | 4/13 | MW-82 |
| | Ethylbenzene | 700 | 50.2 | 9/13 | MW-81 |
| | Methylene chloride | 5 | 5.71 | 10/13[2] | MW-84 |
| | 1,1,2,2-Tetrachloroethane | -- | 0.53 | 2/13 | MW-82 |
| | Toluene | 1000 | 28.7 | 13/13 | K-304 |
| | Trichloroethene | -- | 2.57 | 4/13 | MW-82 |
| | Vinyl chloride | 2 | 0.14 | 2/13 | MW-82 |
| | m&p-Xylene | -- | 202 | 9/13 | MW-81 |
| | o-Xylene | -- | 32.9 | 10/13 | MW-81 |
| SW8080 (µg/L) | Aldrin | -- | 0.0243 | 4/13 | MW-85 |
| | alpha-BHC | -- | 0.0119 P | 2/13 | MW-85 |
| | gamma-BHC(Lindane) | 0.2 | 0.0246 | 5/13 | MW-83 |
| | 4,4'-DDD | -- | 0.0908 | 5/13 | MW-85 |
| | 4,4'-DDE | -- | 0.0875 | 3/13 | MW-85 |
| | 4,4'-DDT | -- | 0.0382 | 3/13 | MW-85 |

## Table 3.3-2

## (Continued)

| Method (units) | Analyte | MCL[1] | Maximum Result | Frequency of Detections Total Hits/ Total Samples | Location of Maximum Result |
|---|---|---|---|---|---|
| SW8080 (µg/L) (continued) | Dieldrin | -- | 0.0324 | 2/13 | MW-83 |
| | Endosulfan II | -- | 0.0053 P | 1/13 | MW-85 |
| | Endrin Aldehyde | -- | 0.032 | 1/13 | MW-85 |
| | Heptachlor | -- | 0.0105 P | 1/13 | MW-85 |
| | Heptachlor epoxide | -- | 0.0603 P | 4/13 | MW-85 |
| SW8270 (µg/L) | Dimethylphthalate | -- | 12.7 | 5/13 | MW-80 |
| | bis(2-Ethylhexyl)phthalate | 6 | 3.08 B | 3/13 | MW-85 |
| | 2-Methylnaphthalene | -- | 12.1 | 3/13 | K-304 |
| | 4-Methylphenol/ 3-Methylphenol | -- | 2.07 F | 2/13 | MW-83 |
| SW8310 (µg/L) | Acenaphthene | -- | 4.04 | 2/13 | MW-85 |
| | Acenaphthylene | -- | 2.4 | 2/13 | MW-85 |
| | Anthracene | -- | 0.307 B | 2/13 | MW-85 |
| | Fluoranthene | -- | 0.241 | 1/13 | MW-85 |
| | Fluorene | -- | 1.2 | 6/13 | MW-85 |
| | Naphthalene | -- | 8.83 | 13/13 | MW-83 |
| | Pyrene | -- | 0.162 | 1/13 | MW-85 |
| SW6010, Total (mg/L) | Antimony | 0.006 | 0.0856 | 1/13 | MW-85 |
| | Barium | 2 | 0.395 | 13/13 | MW-85 |
| | Beryllium | 0.004 | 0.00167 B | 10/13 | MW-82 |
| | Cadmium | 0.005 | 0.00976 | 4/13 | MW-84 |
| | Chromium | 0.1 | 0.04 | 3/13 | MW-85 |
| | Cobalt | -- | 0.0163 | 5/13 | MW-85 |
| | Copper | 1.3[3] | 0.108 | 2/13 | MW-85 |
| | Manganese | -- | 4.03 | 13/13 | MW-81 |
| | Molybdenum | -- | 0.0102 | 2/13 | MW-80 |
| | Nickel | 0.1 | 0.0624 | 4/13 | MW-85 |
| | Vanadium | -- | 0.0554 | 3/13 | MW-85 |
| | Zinc | -- | 0.216 | 10/13 | MW-85 |
| SW7060, Total (mg/L) | Arsenic | 0.05 | 0.0252 | 7/13 | MW-84 |
| SW7421, Total (mg/L) | Lead | 0.015[3] | 0.0508 | 4/13 | MW-85 |
| SW6010, Dissolved (mg/L) | Barium | 2 | 0.25 | 4/5 | MW-85 |
| | Beryllium | 0.004 | 0.0017 B | 3/5 | MW-83 |
| | Cadmium | 0.005 | 0.00491 | 1/5 | MW-84 |
| | Chromium | 0.1 | 0.00861 | 1/5 | MW-85 |
| | Cobalt | -- | 0.00853 | 1/5 | MW-85 |
| | Manganese | -- | 3.96 | 5/5 | MW-81 |
| | Zinc | -- | 0.0218 | 3/5 | MW-81 |



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## Table 3.3-2

## (Continued)

| Method (units) | Analyte | MCL[1] | Maximum Result | Frequency of Detections Total Hits/ Total Samples | Location of Maximum Result |
|---|---|---|---|---|---|
| SW7060, Dissolved (mg/L) | Arsenic | 0.05 | 0.0173 | 2/5 | MW-84 |

[1] Maximum contaminant level (MCL); 40 CFR § 141.61 for Federal MCLs, and 18 AAC 80.070 for State MCLs. Federal and State MCLs are identical for the listed constituents.

[2] Frequency "hits" calculation does not include one or more results removed from the data set because they did not meet QA/QC criteria. Total sample count includes all samples analyzed for the indicated parameter.

[3] From 40 CFR, Section 141.11 for inorganics and Section 141.12 for organics (effective 1 July 1991); however, the lead level is effective only until 7 December 1992. There is no longer an MCL for lead or copper (56 Federal Register 26460, June 7, 1991); however, there is an action level of 0.015 mg/L for lead and 1.3 mg/L for copper.

B - Sample concentration was less than or equal to the blank UTL.
F - Co-elution or interference was suspected.
P - Analyte quantitation not confirmed. Results from primary and secondary GC columns differ by greater than a factor of three.

## Table 3.3-3

## Summary of Seep Analytical Results at Source LF04
## Elmendorf AFB, AK

| Method (units) | Analyte | MCL[1] | Maximum Result | Frequency of Detections Total Hits/ Total Samples | Location of Maximum Result |
|---|---|---|---|---|---|
| **Indicator Parameters** | | | | | |
| SW8015ME (µg/L) | Unidentified organics [UDRO] | -- | 3860 | 1/11 | SP-02 |
| SW8015MP (µg/L) | Unidentified organics [UGRO] | -- | 9480 b | 3/11 | SP-02 |
| | Xylene (total) | 10000 | 1680 | 9/11 | SP-02 |
| SW6010, Total (mg/L) | Aluminum | -- | 1.94 | 9/11 | SP-02 |
| | Calcium | -- | 132 | 11/11 | SP-06 |
| | Iron | -- | 61.1 | 11/11 | SP-02 |
| | Magnesium | -- | 38.6 | 11/11 | SP-06 |
| | Potassium | -- | 2.25 | 11/11 | SP-06 |
| | Sodium | -- | 23.8 | 11/11 | SP-06 |
| **Contaminant Parameters** | | | | | |
| SW8015MP (µg/L) | Gasoline | -- | 9150 | 3/11 | SP-02 |
| SW8260 (µg/L) | Acetone | -- | 15.5 FB | 9/11 | SP-03 |
| | Benzene | 5 | 289 | 6/11 | SP-02 |
| | Carbon disulfide | -- | 0.58 | 2/11 | SP-02 |
| | Chloromethane | -- | 2.23 B | 3/11 | SP-03 |
| | 1,1-Dichloroethane | -- | 0.1 B | 1/11 | SP-03 |
| | 1,2-Dichloroethane | 5 | 1.41 B | 3/11[2] | SP-01 |
| | Ethylbenzene | 700 | 290 X | 6/11 | SP-02 |
| | Methylene chloride | 5 | 6.53 | 9/11[2] | SP-06 |
| | Styrene | 100 | 9.85 | 1/11 | SP-02 |
| | Toluene | 1000 | 840 | 5/11 | SP-02 |
| | m&p-Xylene | -- | 896 X | 6/11 | SP-02 |
| | o-Xylene | -- | 485 | 5/11 | SP-02 |
| SW8270 (µg/L) | 2-4-Dimethylphenol | -- | 18.2 | 2/11 | SP-02 |
| | 2-Methylnaphthalene | -- | 18.2 | 4/11 | SP-04 |
| | 2-Methylphenol (o-cresol) | -- | 16.9 | 2/11 | SP-02 |
| | 4-Methylphenol/ 3-Methylphenol | -- | 17.3 F | 2/11 | SP-02 |
| | Phenol | -- | 4.36 | 1/11 | SP-02 |
| SW8310 (µg/L) | Acenaphthene | -- | 27.1 | 4/11 | SP-02 |
| | Acenaphthylene | -- | 7.23 | 1/11 | SP-04 |
| | Benzo(b)fluoranthene | 0.2 | 0.0819 | 3/11 | SP-02 |
| | Benzo(k)fluoranthene | 0.2 | 0.0075 B | 2/11 | SP-03 |
| | Chrysene | 0.2 | 0.136 | 2/11 | SP-02 |
| | Fluorene | -- | 1.26 | 3/11 | SP-04 |
| | Naphthalene | -- | 51.5 | 3/11 | SP-04 |
| SW6010, Total (mg/L) | Barium | 2 | 0.0698 | 11/11 | SP-03 |
| | Beryllium | 0.004 | 0.00168 B | 2/11 | SP-07 |
| | Chromium | 0.005 | 0.00911 | 1/11 | SP-02 |



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## Table 3.3-3

## (Continued)

| Method (units) | Analyte | MCL[1] | Maximum Result | Frequency of Detections Total Hits/ Total Samples | Location of Maximum Result |
|---|---|---|---|---|---|
| SW6010, Total (mg/L) (continued) | Cobalt | -- | 0.00844 | 4/11 | SP-04 |
| | Copper | 1.3 [3] | 0.0118 | 1/11 | SP-02 |
| | Manganese | -- | 7.94 | 1/11 | SP-02 |
| | Molybdenum | -- | 0.00967 | 2/11 | SP-02 |
| | Nickel | 0.1 | 0.0182 | 1/11 | SP-02 |
| | Vanadium | -- | 0.0202 | 2/11 | SP-02 |
| | Zinc | -- | 0.0169 B | 7/11 | SP-02 |
| SW7060, Total (mg/L) | Arsenic | 0.05 | 0.0963 | 7/11 | SP-02 |
| SW7421, Total (mg/L) | Lead | 0.015 [3] | 0.00303 | 1/11 | SP-02 |

[1] Maximum contaminant level (MCL); 40 CFR § 141.61 for Federal MCLs, and 18 AAC 80.070 for State MCLs. Federal and State MCLs are identical for the listed constituents.

[2] Frequency "hits" calculation does not include one or more results removed from the data set because they did not meet QA/QC criteria. Total sample count includes all samples analyzed for the indicated parameter.

[3] From 40 CFR, Section 141.11 for inorganics and Section 141.12 for organics (effective 1 July 1991); however, the lead level is effective only until 7 December 1992. There is no longer an MCL for lead or copper (56 Federal Register 26460, June 7, 1991); however, there is an action level of 0.015 mg/L for lead and 1.3 mg/L for copper.

b - Due to high concentrations of other target compounds in the sample, or to interference by non-target analytes, the sample could not be run at a dilution factor of one. The flagged analyte concentrations is less than the blank UTL times the sample dilution factor.

B - Sample concentration was less than or equal to the blank UTL.

F - Co-elution or interference was suspected.

X - The recoveries of one or more of the internal standards were outside the applicable acceptance criteria. The X-flag indicates which compounds were quantitated using the affected internal standard(s).



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## Table 3.3-4

## Summary of Surface Soil Analytical Results for Source LF04
## Elmendorf AFB, AK

| Method (units) | Analyte | ACM | Background Upper Tolerance Limit | Maximum Result | Frequency of Detection total hits/ total samples | Location of Maximum Result |
|---|---|---|---|---|---|---|
| **Indicator Parameters** | | | | | | |
| SW9045 (pH units) | pH | -- | -- | 7.99 | 5/5 | SS-046 |
| D2216 (percent) | Percent moisture | -- | -- | 59.6 | 54/54 | SS-023 |
| SW8015ME (mg/kg) | Unidentified organics [UDRO] | 1000 | -- | 2910 | 10/11 | SS-003 |
| SW8015MP (mg/kg) | Unidentified organics [UGRO] | 500 | -- | 3.6 B | 4/11 | MW-63 |
| SW6010 (mg/kg) | Aluminum | -- | 31183.96 | 22100 | 53/53 | SS-021 |
| | Calcium | -- | 8013.23 | 13400 | 53/53 | SS-034 |
| | Iron | -- | 43192.35 | 151000 | 53/53 | SS-023 |
| | Magnesium | -- | 10904.10 | 10900 | 53/53 | SS-045 |
| | Potassium | -- | 845.75 | 2830 | 53/53 | SS-029 |
| | Sodium | -- | 427.05 | 2280 | 53/53 | SS-037 |
| **Contaminant Parameters** | | | | | | |
| SW8015ME (mg/kg) | Diesel | 1000 | -- | 103 | 1/11 | SS-002 |
| SW8015MP (µg/kg) | Benzene | 500 | -- | 47.4 | 4/11 | SS-004 |
| | Ethylbenzene | 50000 | -- | 89.4 | 3/11 | SS-005 |
| | Xylene (total) | 50000 | -- | 315 | 8/11 | SS-005 |
| SW8240 (µg/kg) | Acetone | -- | -- | 139 | 53/53 | SS-024 |
| | 2-Butanone(MEK) | -- | -- | 16.5 B | 4/53 | SS-024 |
| | Methylene chloride | -- | -- | 83.2 X | 30/53 | SS-013 |
| | 1,1,2,2-Tetrachloroethane | -- | -- | 19.8 | 1/53 | SS-017 |
| | Toluene | 50000 | -- | 6.82 | 4/53 | SS-032 |
| | Trichloroethene | -- | -- | 11.3 | 1/53 | SS-017 |
| | m & p-Xylene | 50000 | -- | 5.46 | 1/53 | MW-78 |
| | o-Xylene | 50000 | -- | 2.11 | 1/53 | MW-78 |
| SW8080 (µg/kg) | Aldrin | -- | -- | 22.2 | 24/53 | SS-014 |
| | alpha-BHC | -- | -- | 1.22 | 11/53 | SS-024 |
| | beta-BHC | -- | -- | 9.44 P | 2/53 | SS-046 |
| | delta-BHC | -- | -- | 10.3 | 16/53 | SS-039 |
| | gamma-BHC(Lindane) | -- | -- | 31.3 P | 45/53 | SS-021 |
| | 4,4'-DDD | -- | -- | 8410 | 49/53 | SS-001 |
| | 4,4'-DDE | -- | -- | 1690 | 49/53 | SS-001 |
| | 4,4'-DDT | -- | -- | 47300 | 50/53 | SS-001 |
| | Dieldrin | -- | -- | 143 P | 19/53 | SS-001 |
| | Endosulfan I | -- | -- | 11.7 P | 9/53 | SS-038 |
| | Endosulfan II | -- | -- | 4.88 | 3/53 | SS-006 |
| | Endrin | -- | -- | 22.6 W | 4/53 | SS-013 |
| | Endrin Aldehyde | -- | -- | 5.32 | 10/53 | SS-017 |
| | Heptachlor | -- | -- | 8.44 W | 7/53 | SS-040 |
| | Heptachlor epoxide | -- | -- | 23 | 16/53 | SS-038 |
| | PCB-1254 | -- | -- | 3120 | 1/53 | SS-013 |



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**Table 3.3-4**

**(Continued)**

| Method (units) | Analyte | ACM | Background Upper Tolerance Limit | Maximum Result | Frequency of Detection total hits/ total samples | Location of Maximum Result |
|---|---|---|---|---|---|---|
| SW8080 (μg/kg) (continued) | PCB-1260 | -- | -- | 318 | 1/53 | SS-040 |
| SW8270 (mg/kg) | Benzo(a)anthracene | -- | -- | 0.23 | 6/53 | SS-046 |
| | Benzo(a)pyrene | -- | -- | 0.184 | 3/53 | SS-046 |
| | Benzo(b)fluoranthene | -- | -- | 0.466 F | 3/53 | SS-046 |
| | Benzo(g,h,i)perylene | -- | -- | 0.24 | 2/53 | SS-046 |
| | Benzo(k)fluoranthene | -- | -- | 0.466 F | 4/53 | SS-046 |
| | Chrysene | -- | -- | 0.391 | 7/53 | SS-046 |
| | Dibenzofuran | -- | -- | 0.0894 | 4/53 | SS-021 |
| | 1,4-Dichlorobenzene | -- | -- | 0.0349 | 1/53 | SS-040 |
| | Diethylphthalate | -- | -- | 0.016 | 1/53 | SS-038 |
| | bis(2-Ethylhexyl)phthalate | -- | -- | 1.98 | 6/53 | SS-007 |
| | Fluoranthene | -- | -- | 0.345 | 7/53 | SS-046 |
| | Indeno(1,2,3-cd)pyrene | -- | -- | 0.151 | 2/53 | SS-046 |
| | 2-Methylnaphthalene | -- | -- | 1.96 | 9/53 | SS-014 |
| | 4-Methylphenol/ 3-Methylphenol | -- | -- | 0.0798 F | 1/53 | SS-040 |
| | Naphthalene | -- | -- | 1.15 | 4/53 | SS-014 |
| | Phenanthrene | -- | -- | 0.3 | 9/53 | SS-046 |
| | Pyrene | -- | -- | 0.516 | 7/53 | SS-046 |
| | 1,2,4-Trichlorobenzene | -- | -- | 0.108 | 1/53 | SS-040 |
| SW8280 (μg/kg) | HpCDD Totals | -- | -- | 11.7 | 6/53 | SS-013 |
| | HpCDF Totals | -- | -- | 6.1 | 3/53 | SS-013 |
| | HxCDD Totals | -- | -- | 4.68 | 3/53 | SS-038 |
| | HxCDF Totals | -- | -- | 1.2 | 2/53 | SS-013 |
| | OCDD | -- | -- | 79.9 | 8/53 | SS-013 |
| | OCDF | -- | -- | 6.63 | 2/53 | SS-013 |
| | PeCDD Totals | -- | -- | 1.04 | 1/53 | SS-046 |
| | TCDD Totals | -- | -- | 1.1 | 1/53 | SS-046 |
| | TCDF Totals | -- | -- | 0.197 | 2/53 | SS-039 |
| SW6010 (mg/kg) | Antimony | -- | NA | 24.7 | 2/53 | SS-046 |
| | Barium | -- | 196.45 | 1930 | 53/53 | SS-013 |
| | Beryllium | -- | 0.76 | 0.762 | 51/53 | SS-013 |
| | Cadmium | -- | 2.68 | 6.96 | 6/53 | SS-044 |
| | Chromium | -- | 48.44 | 71.3 | 53/53 | SS-046 |
| | Cobalt | -- | 19.52 | 20.9 | 53/53 | SS-023 |
| | Copper | -- | 31.67 | 440 | 53/53 | SS-037 |
| | Manganese | -- | 929.98 | 4640 | 53/53 | SS-023 |
| | Molybdenum | -- | NA | 6.52 | 34/53 | SS-046 |
| | Nickel | -- | 50.68 | 46 | 52/53 | SS-038 |
| | Selenium | -- | 0.54 | 11 | 4/53 | SS-009 |
| | Silver | -- | 1.68 | 4.74 | 39/53 | SS-037 |

## Table 3.3-4

## (Continued)

| Method (units) | Analyte | ACM | Background Upper Tolerance Limit | Maximum Result | Frequency of Detection total hits/ total samples | Location of Maximum Result |
|---|---|---|---|---|---|---|
| SW6010 (mg/kg) (continued) | Thallium | -- | NA | 8.75 | 1/53 | SS-046 |
| | Vanadium | -- | 101.64 | 81.2 | 53/53 | SS-013 |
| | Zinc | -- | 90.01 | 757 | 52/53 | SS-037 |
| SW7060 (mg/kg) | Arsenic | -- | 13.27 | 56.5 | 53/53 | SS-023 |
| SW7421 (mg/kg) | Lead | -- | 10.69 | 1160 | 53/53 | SS-037 |

ACM - Alaska Cleanup Matrix, Level C.
B - Sample concentration was less than or equal to the blank UTL.
F - Co-elution or interference was suspected.
NA - Not applicable.
P - Analyte quantitation not confirmed. Results from primary and secondary GC columns differ by greater than a factor of three.
W - Due to the presence of PCB-1260, it was not possible to quantitate this compound on the primary column. The unconfirmed result for the secondary column is reported.
X - The recoveries of one or more of the internal standards were outside the applicable acceptance criteria. The X-flag indicates which compounds were quantitated using the affected internal standard(s).

Table 3.3-5

**Summary of Subsurface Soil Analytical Results for Source LF04**
**Elmendorf AFB, AK**

| Method (units) | Analyte | ACM | Background Upper Tolerance Limit | Maximum Result | Frequency of Detection total hits/ total samples | Location of Maximum Result |
|---|---|---|---|---|---|---|
| **Indicator Parameters** | | | | | | |
| SW9045 (pH units) | pH | -- | -- | 8.3 | 10/10 | SB-65 |
| D2216 (percent) | Percent moisture | -- | -- | 26.2 | 26/26 | SB-65 |
| SW8015ME (mg/kg) | Unidentified organics [UDRO] | 1000 | -- | 189 | 11/12 | SB-65 |
| SW8015MP (mg/kg) | Unidentified organics [UGRO] | 500 | -- | 14 B | 7/15 | SB-65 |
| SW6010 (mg/kg) | Aluminum | -- | 18116.77 | 24700 | 12/12 | MW-77 |
| | Calcium | -- | 10264.39 | 16400 | 12/12 | MW-77 |
| | Iron | -- | 38483.64 | 35900 | 12/12 | MW-77 |
| | Magnesium | -- | 14784.34 | 13200 | 12/12 | MW-77 |
| | Potassium | -- | 1114.35 | 2090 | 12/12 | MW-77 |
| | Sodium | -- | 365.59 | 414 | 12/12 | SB-65 |
| **Contaminant Parameters** | | | | | | |
| SW8015ME (mg/kg) | Diesel | 1000 | -- | 47.7 | 1/12 | SB-62 |
| SW8015MP (μg/kg) | Benzene | 500 | -- | 694 | 5/15 | MW-77 |
| | Ethylbenzene | 50000 | -- | 32800 | 4/15 | MW-63 |
| | Gasoline | 500000 | -- | 5880000 | 3/15 | MW-63 |
| | Toluene | 50000 | -- | 14000 | 10/15 | SB-62 |
| | Xylene (total) | 50000 | -- | 65900 | 9/15 | SB-62 |
| SW8240 (μg/kg) | Acetone | -- | -- | 4660 | 14/15 | MW-63 |
| | 2-Butanone(MEK) | -- | -- | 10.3 B | 3/15 | SB-65 |
| | Methylene chloride | -- | -- | 18.3 | 1/15 | SB-65 |
| | Styrene | -- | -- | 14.6 | 1/15 | SB-65 |
| | m & p-Xylene | -- | -- | 6920 | 5/15 | MW-63 |
| | o-Xylene | -- | -- | 2470 | 4/15 | SB-62 |
| SW8080 (μg/kg) | Aldrin | -- | -- | 11 | 4/12 | SB-65 |
| | delta-BHC | -- | -- | 17.6 P | 1/12 | SB-65 |
| | gamma-BHC(Lindane) | -- | -- | 3.06 | 7/12 | MW-77 |
| | 4,4'-DDD | -- | -- | 139 P | 2/12 | SB-65 |
| | 4,4'-DDE | -- | -- | 29.4 | 1/12 | SB-65 |
| | 4,4'-DDT | -- | -- | 177 | 3/12 | SB-65 |
| | Heptachlor epoxide | -- | -- | 0.575 B | 1/12 | MW-78 |
| SW8270 (mg/kg) | Benzo(a)anthracene | -- | -- | 0.0213 F | 1/12 | MW-77 |
| | Benzoic acid | -- | -- | 2.14 | 1/12 | SB-65 |
| | Benzyl alcohol | -- | -- | 4.3 | 1/12 | SB-65 |
| | Butylbenzylphthalate | -- | -- | 0.0335 | 1/12 | MW-63 |
| | Chrysene | -- | -- | 0.0351 | 1/12 | MW-77 |
| | Dibenzofuran | -- | -- | 0.019 | 1/12 | MW-77 |
| | Diethylphthalate | -- | -- | 0.183 | 1/12 | MW-77 |
| | Dimethylphthalate | -- | -- | 0.0655 | 1/12 | MW-77 |



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## Table 3.3-5

## (Continued)

| Method (units) | Analyte | ACM | Background Upper Tolerance Limit | Maximum Result | Frequency of Detection total hits/ total samples | Location of Maximum Result |
|---|---|---|---|---|---|---|
| SW8270 (mg/kg) (continued) | bis(2-Ethylhexyl)phthalate | -- | -- | 6.7 | 3/12 | SB-65 |
| | Fluorene | -- | -- | 0.0323 | 2/12 | MW-77 |
| | 2-Methylnaphthalene | -- | -- | 0.49 | 3/12 | SB-62 |
| | 2-Methylphenol (o-cresol) | -- | -- | 0.0439 | 1/12 | SB-62 |
| | 4-Methylphenol/ 3-Methylphenol | -- | -- | 0.0461 F | 1/12 | SB-62 |
| | Naphthalene | -- | -- | 0.178 | 3/12 | SB-62 |
| | Phenanthrene | -- | -- | 0.105 | 2/12 | MW-77 |
| SW6010 (mg/kg) | Barium | -- | 95.93 | 411 | 12/12 | SB-65 |
| | Beryllium | -- | 0.64 | 0.562 | 12/12 | MW-77 |
| | Chromium | -- | 76.94 | 55.9 | 12/12 | MW-63 |
| | Cobalt | -- | 17.62 | 14.8 | 12/12 | MW-77 |
| | Copper | -- | 59.84 | 78.1 | 12/12 | MW-63 |
| | Manganese | -- | 709.45 | 709 | 12/12 | MW-77 |
| | Molybdenum | -- | -- | 9.68 | 10/12 | MW-63 |
| | Nickel | -- | 71.79 | 36.9 | 12/12 | MW-77 |
| | Silver | -- | 1.06 | 0.744 | 4/12 | MW-77 |
| | Vanadium | -- | 66.16 | 74.9 | 12/12 | MW-77 |
| | Zinc | -- | 76.17 | 77.8 | 12/12 | MW-77 |
| SW7060 (mg/kg) | Arsenic | -- | 9.31 | 11.3 | 12/12 | MW-77 |
| SW7421 (mg/kg) | Lead | -- | 10.13 | 11.2 | 12/12 | SB-65 |

ACM - Alaska Cleanup Matrix, Level C
B - Sample concentration was less than or equal to the blank UTL.
F - Co-elution or interference was suspected.
P - Analyte quantitation not confirmed. Results from primary and secondary GC columns differ by greater than a factor of three.

Indicator parameters primarily include metals classified as nutrients, and non-speciated fuel constituents such as unidentified diesel range organics (UDRO) which are unsuitable for use in a risk assessment. A detailed discussion of the determination of the COCs for LF04 is presented in Section 3.3.3.

**Groundwater Contamination at LF04**

Groundwater data at LF04 was characterized as three separate groups, based upon the hydrogeology at the site. As discussed in Section 3.1, several different aquifers occur at LF04, in addition to groundwater seeps. The groundwater data were separated into groundwater data on the bluff (which combines the first two aquifers encountered) (Table 3.3-1), groundwater data from the beach (water from the third aquifer) (Table 3.3-2), and groundwater seep data (Table 3.3-3). The predominant types of groundwater contamination detected at LF04 include volatile organic compounds (VOCs), BTEX constituents, fuels, metals, and pesticides. In general, the most contaminated hydrogeologic regime was the bluff, where benzene concentrations were recorded at a maximum of 3400 $\mu$g/L in a sample from MW-61 (Table 3.3-1). Other BTEX constituents were also elevated in samples from that well and MW-77. Additionally, 2.28 inches of free phase floating product was found at MW-77 during a 1995 field investigation. In addition to BTEX, elevated levels of heavier hydrocarbons, such as SVOCs were detected, as well as low levels of solvents and pesticides. Constituents in these groups were generally detected less frequently in the bluff groundwater than BTEX constituents and were at significantly lower concentrations. Locations for all remedial investigation soil and groundwater sampling points within LF04 are presented in Section 3.3.3.

Numerous metals were also detected in the bluff groundwater at LF04. These include relatively low concentrations of barium, beryllium, cadmium, chromium, cobalt, copper, manganese, nickel, selenium, vanadium, and zinc (Table 3.3-1). As at WP14, a comparison of these metals concentrations was made to available background metals concentration from the *Elmendorf Air Force Base, Alaska, Basewide Background Sampling Report* (USAF, 1993b). Based on a comparison between mean background confidence intervals and mean LF04 metals data, all metals in the bluff groundwater at LF04 were determined to be at or near background concentrations. The summary statistics for the USGS data, including the upper confidence limit concentrations used for these comparisons, are presented in Table 2.3-4.

In the groundwater data collected along the beach at LF04, VOCs, including benzene, were significantly lower than those on the bluff (Table 3.3-2). A notable exception to this was the occurrence of speciated jet fuel and gasoline, which were not detected in the bluff groundwater. Gasoline was detected in the beach aquifer at 5160 $\mu$g/L in a sample from well K-304. Pesticides, SVOCs, and other heavy hydrocarbons were also identified in the beach groundwater, but as on the bluff, these constituents were detected rather infrequently and at relatively low concentrations. Based upon a statistical comparison to the USGS background data, all metals detected in the beach groundwater at LF04 were determined to be at or near background concentrations.

Seep data at LF04 indicates contamination of seep water predominantly by BTEX constituents and fuels. Benzene was reported at a maximum concentration of 289 $\mu$g/L in the sample from seep SP-02. Elevated fuels were also reported occurring at this seep, with gasoline reaching a maximum of 9150 $\mu$g/L. Of the contaminant parameters detected, most occurred at this seep (Table 3.3-3). In addition to fuels constituents, other volatile organic compounds were detected, as were SVOCs, and polynuclear aromatic hydrocarbons (PAHs). These constituents occurred at low levels, and in statistically few samples. No pesticides were detected in the beach groundwater. Metals were detected, but these were determined to be at or near background levels.

**Soil Contamination at LF04**

Soil data from LF04 were evaluated based upon surface and subsurface contaminant occurrences. Surface soils include all soils collected from depths shallower than 3 feet bgs. Subsurface soils are those collected from below 3 feet. Tables 3.3-4 and 3.3-5 list the sample depths, maximum concentrations, locations, and guidelines associated with the ACM for non-UST soil for all contaminant parameters in the surface and subsurface soil samples at LF04. Results below the detection limits are not included in the analytical summary tables.

Contamination in the soils at LF04 consists primarily of fuels, weathered fuel residuals, pesticides, metals and dioxins. BTEX constituents were detected in both surface and subsurface soils. The maximum BTEX occurrence in the surface soils was detected for xylene at SS-005 at 315 $\mu$g/kg. Pesticides, such as 4,4'-DDD and 4,4'-DDT, were detected frequently in the surface soils at LF04, however the average concentrations of these constituents was low. Isolated occurrences of elevated concentrations along roadways are indicative of residual pesticides from surface applications rather than pesticides occurring as the result of an undocumented release. Numerous dioxins were also detected in the surface soils at LF04, particularly in the soils on the beach. The dioxins occur at very low levels, and appear to be the result of the incomplete burning of wastes within the bluff landfill.

The contaminant levels in the subsurface soils exceeded those of the surface soils at LF04. Most of the elevated volatile constituents in the subsurface soils are associated with smear zone contamination near the water table. The maximum BTEX occurrence in the subsurface soils at LF04 was xylene at 65,900 $\mu$g/kg in a soil sample from boring SB-62. Pesticides and SVOCs occurred at significantly lower concentrations in both surface and subsurface soils than fuel constituents. Dioxins were not identified in subsurface soils (Table 3.3-5). The soil COCs for LF04 are presented in Section 3.3.3.

Metals were identified in both surface and subsurface soils at LF04. The metals detected were determined to be predominantly at or near background concentrations. The background results used in the metals evaluation at LF04 are included in the soil analytical tables (Tables 3.3-4 and 3.3-5). Analytical results from the basewide background sampling event (USAF, 1993) were pooled into surface and subsurface soil results, and were used as the basis to conduct statistical comparisons with on-site results.

### 3.3.2 Risk Evaluation

Based on the concentrations of contaminants detected during the RI, human health and environmental risk assessments were performed to determine if areas should be considered for remedial action. All concentrations of contaminants, including all contaminants of concern, whether exceeding MCLs or ACM guidelines or not, were included in the risk assessments. The general discussion of the human health and ecological risk assessment procedures is presented in Section 2.3.2, and will not be repeated since the procedures for each of the source areas within OU 6 were identical. Details on the parameters used in the Health Risk Assessment are shown on Table 2.3-5.

**Human Health Risk Assessment (HRA)**

Since LF04 is not currently used residentially, a *current* residential risk scenario was not evaluated, and only current visitor and trench worker scenarios were applied. Even though the future land use at LF04 is restricted as specified in the Base Comprehensive Plan, the *future* residential risk scenario was evaluated to obtain the most conservative risk information possible.



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ELCRs and HIs were calculated to describe cancer and noncancer risks, respectively. The ELCR is the additional chance that an individual exposed to site contamination will develop cancer during his/her lifetime. It is expressed as a probability such as 1.0E-06 (one in a million). The HI estimates the likelihood that exposure to the contamination will cause some negative health effect. An HI score above one indicates that some people exposed to the contamination may experience at least one negative health effect.

The calculated risks at LF04 are based on hypothetical exposure to soil and groundwater. Groundwater risk at LF04 was calculated separately for the bluff and the beach, since these two areas were distinct geographically and had differing types and concentrations of contaminants. The shallow groundwater aquifers at LF04 are not presently used and will not be used in the future for supplying potable or non-potable water. For carcinogenic soil risk, the calculated results for the future resident reasonable maximum exposure (RME), construction worker, and visitor are listed. Only the future resident scenario (RME) was used to calculate carcinogenic groundwater risk. Table 3.3-6 summarizes the calculated carcinogenic and noncarcinogenic human health risks calculated for LF04.

Groundwater carcinogenic risk at the bluff for the residential scenario (RME) exceeded 1.0E-03. Benzene is the predominant risk driver, with several other constituents, primarily solvents and pesticides, driving the risk. This risk is consistent with that identified for the groundwater at WP14, further supporting the conclusion that the aquifers in these locations are interconnected. 1,2-Dichloroethane and toluene are the primary contributor to the RME noncarcinogenic risk, which exceeded an acceptable HI of 1.0. Beach groundwater RME risk was moderately elevated at 1.7E-05. As for the bluff groundwater, solvents, pesticides and benzene were the primary beach risk contributors. The noncarcinogenic risk for the beach groundwater was at an acceptable level (Table 3.3-6).

Shallow soil carcinogenic RME risk at the LF04 beach and bluff were at similar levels, near 1.0E-05. The visitor scenario risk also slightly exceeded 1.0E-06 for both areas. The noncarcinogenic risk for RME soils in both areas exceeded 1.0. Risk to trench workers from subsurface soil is at an acceptable level. Bluff soil risk was attributable to metals, pesticide and dioxin contamination. Bluff soil risk was caused by metals and dioxins only.

**Ecological Risk Assessment (ERA)**

The ERA was performed to determine if the reported concentrations of chemicals or calculated exposures to plants and wildlife at OU 6 are likely to produce adverse effects. Ecological effects were evaluated quantitatively by calculating Ecological Quotients (EQs). The ERA focused on evaluating potential impacts of the contamination on selected indicator species: the moose, masked shrew, meadow vole, black-capped chickadee, merlin, and peregrine falcon. The spotted sandpiper was also identified as an indicator species for evaluating ecological risk on the beach. The general discussion of the ecological risk assessment procedures is presented in Section 2.3.2 and will not be repeated since the procedures for each of the source areas within OU 6 were identical.

Calculated EQs for the bluff soils exceeded 1.0 for small animals due to concentrations of barium, lead, benzo(a)anthracene, and seven pesticides. The highest EQ was associated with barium and equals 8300 for the black capped chickadee. This is followed by lead, which has an EQ of 4600, also for the black capped chickadee. EQs on the beach soils also exceeded 1.0 due to copper, lead and zinc concentrations for small animals, as well as numerous pesticides and SVOCs. The highest EQs are associated with lead for the black capped chickadee, masked shrew and spotted sandpiper (24,000, 7400, and 3800, respectively) and with 4,4'-DDE (3800), also for the spotted sandpiper. EQs were calculated

## Table 3.3-6

### Summary of Human Health Risks at LF04
### Elmendorf AFB, AK

| Risk | Surface Soil (<3 feet) | | Subsurface Soil | Chemical(s) Driving Risk |
|---|---|---|---|---|
| | Residential Scenario[a] | Visitor Scenario[b] | Trench Worker Scenario[c] | |
| **Soil Risk Beach[d]** | | | | |
| Carcinogenic | 4.4E-05 | 2.7E-06 | NA | Arsenic, HxCDD, TCDF, HpCDD |
| Non-Carcinogenic | 2.78 | 0.14 | NA | Arsenic, Manganese |
| **Soil Risk Bluff[d]** | | | | |
| Carcinogenic | 2.8E-05 | 1.7E-06 | <1.0E-06 | Arsenic, 4,4'-DDT, HpCDD |
| Non-Carcinogenic | 4.0 | 0.2 | NR | Arsenic, 4,4'-DDT, Manganese |
| **Groundwater Risk Beach[d]** | | | | |
| Carcinogenic | 1.7E-05 | NA | NA | Benzene, Heptachlor epoxide, Dieldrin, Aldrin, 1,1,2,2-Tetrachloroethane, Vinyl Chloride |
| Non-Carcinogenic | <0.1 | NA | NA | None |
| **Groundwater Risk Bluff[d]** | | | | |
| Carcinogenic | 2.6E-03 | NA | NA | Benzene, 1,2-Dichloroethane, Methylene Chloride, Vinyl Chloride, Chloromethane, Aldrin, Dieldrin, Alpha-BHC |
| Non-Carcinogenic | 2.4 | NA | NA | 1,2 - Dichloroethane, Methylene Chloride, Aldrin, Dieldrin, Toluene, Ethylbenzene |
| **Bluff Seeps** | | | | |
| NR | Only evaluated for visitor scenario. No significant risks identified. | | | |

[a] Excess cancer risks conservatively assumed for 30 years of exposure (drinking groundwater, contact with soil, etc.) by future residents (Reasonable Maximum Exposure).
[b] Excess cancer risks conservatively assumed for 30 years of exposure while visiting the site under current conditions.
[c] Excess cancer risks conservatively assumed for 1 year of exposure during on-site construction work (digging, etc.).
[d] Risks are calculated by using the 95% upper confidence limits (UCLs) for contaminants present unless the 95% UCL exceeded the maximum concentration detected, in which case the maximum concentration was used. This represents a conservative estimate of the "worst case" contamination.
NA - Not applicable.
NR - Significant risk not identified.

based on surface soil and seep contaminant concentrations. None of the calculated EQs exceeded 1.0 for the moose, peregrine falcon, or merlin at LF04.

The sandpiper had the most EQ exceedances for constituents in the beach soils, some exceedances being substantial. It should be noted that sandpipers are infrequent users of the beach, and that their period of occupancy is only a maximum of about 5 months. This 5 month occupancy factor was incorporated into the exposure evaluation.

**Uncertainties Associated with the Risk Assessment**

The major assumptions and uncertainty factors for the OU 6 human health and ecological risk assessments are presented in Section 2.3.2.

### 3.3.3 Conclusions

The following subsections provide a discussion of the determination of COCs for LF04, the location and extent of contamination by COCs in excess of preliminary remediation goals, and a summary statement about the risk to public health, welfare, or the environment if action is not taken at LF04.

**Contaminants of Concern**

Constituents exceeding preliminary remediation goals (MCLs for groundwater, ACM guidelines for soils) were identified in the Proposed Plan. COCs were developed from the results of the risk assessment and by considering preliminary remediation goals. Each constituent having an individual contribution of greater than 1.0E-06 carcinogenic (RME) risk, or an HI greater than 0.1 when the cumulative number for the site is greater than 1.0, was considered as a COC. In addition, any constituent exceeding preliminary remediation goals (MCLs for groundwater or ACM guidelines for soil) was also considered as a COC. The final COCs for LF04 are shown on Table 3.3-7, with the individual risk contributed and basis for identifying the COC (risk or regulatory standard).

Five COCs were identified for groundwater at LF04: benzene; ethylbenzene; toluene; 1,2-dichloroethane; and methylene chloride (Table 3.3-7). These constituents contributed to a broad plume of contamination in the groundwater at LF04 (and WP14), which was originally presented for fuels as Figure 2.3-1. The estimated volume of this plume is 45.5 million gallons. A second map, depicting the plume of chlorinated species at LF04, is presented as Figure 3.3-1. Since chlorinated solvents were not COCs at WP14, this map is limited to the LF04 area only. The estimated volume of the chlorinated solvent plume is 17.7 million gallons. Both plumes are drawn based upon concentrations exceeding 5 $\mu$g/L, which is the MCL for benzene and 1,2-dichloroethane.

The groundwater fuel plume at LF04 encompasses most of the southern portion of LF04 (LF04 South). The solvent plume is not as pervasive, being limited to an area in the center of LF04 South. Because the groundwater COCs at LF04 are found exclusively in the southern portion of the source area, LF04 was divided into LF04 South and LF04 North for the purposes of the evaluation and selection of groundwater remedial alternatives. This convention is followed in Sections 3.4 and 3.5.

The Proposed Plan identified three additional groundwater constituents as exceeding their regulatory levels: bis(2-ethylhexyl)phthalate, cadmium, and selenium. Three other metals, chromium, nickel, and arsenic, also exceeded MCLs. Bis(2-Ethylhexyl)phthalate was not identified as a COC, because detection of this compound was associated with sampling in the presence of fuel and not with historic land uses. The five metals were not identified as COCs because: (1) their identification as


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# Table 3.3-7

## Summary of Contaminants of Concern[1] at LF04
## Elmendorf AFB, AK

| Chemical | Maximum Concentration | Maximum Cancer Risk | Maximum Hazard Index | Basis for COC | Remediation Goal | Basis for Remediation Goal |
|---|---|---|---|---|---|---|
| **Groundwater:** | | | | | | |
| Benzene | 3400 µg/L | 1.4E-03 | -- | Exceeds MCL; contributes to a risk > 1.0E-06 | 5 µg/L | MCL |
| Ethylbenzene | 722 µg/L | -- | 0.43 | Exceeds MCL; contributes to HI > 1 | 700 µg/L | MCL |
| Toluene | 3020 µg/L | -- | 0.67 | Exceeds MCL; contributes to HI > 1 | 1000 µg/L | MCL |
| 1,2-Dichloroethane | 38.7 µg/L | 3.7E-05 | 1.2 | Exceeds MCL; contributes to a risk > 1.0E-06; contributes to HI >1 | 5 µg/L | MCL |
| Methylene chloride | 290 µg/L | 6.3E-06 | <0.1 | Exceeds MCL; contributes to a risk > 1.0E-06 | 5 µg/L | MCL |
| **Shallow Soils (0-5 feet bgs):** | | | | | | |
| Exposed landfill waste | -- | -- | -- | Alaska solid waste regulations | -- | -- |
| **Deep Soils (>5 feet bgs):** (No COCs for Deep Soils) | | | | | | |

1 Cancer risk ≥ 1.0E-06 or HI ≥ 0.1 for soil or groundwater scenario with a total HI of ≥ 1.0; or concentrations found in excess of regulatory levels. If cancer risk or HI did not exceed standards, it was marked as "--".

bgs - Below ground surface

COC - Contaminant of Concern

MCL - Maximum Contaminant Level (40 CFR § 141.61 for Federal MCLs; 18 AAC 80.070 for State MCLs). Federal and State MCLs are identical for the COCs.

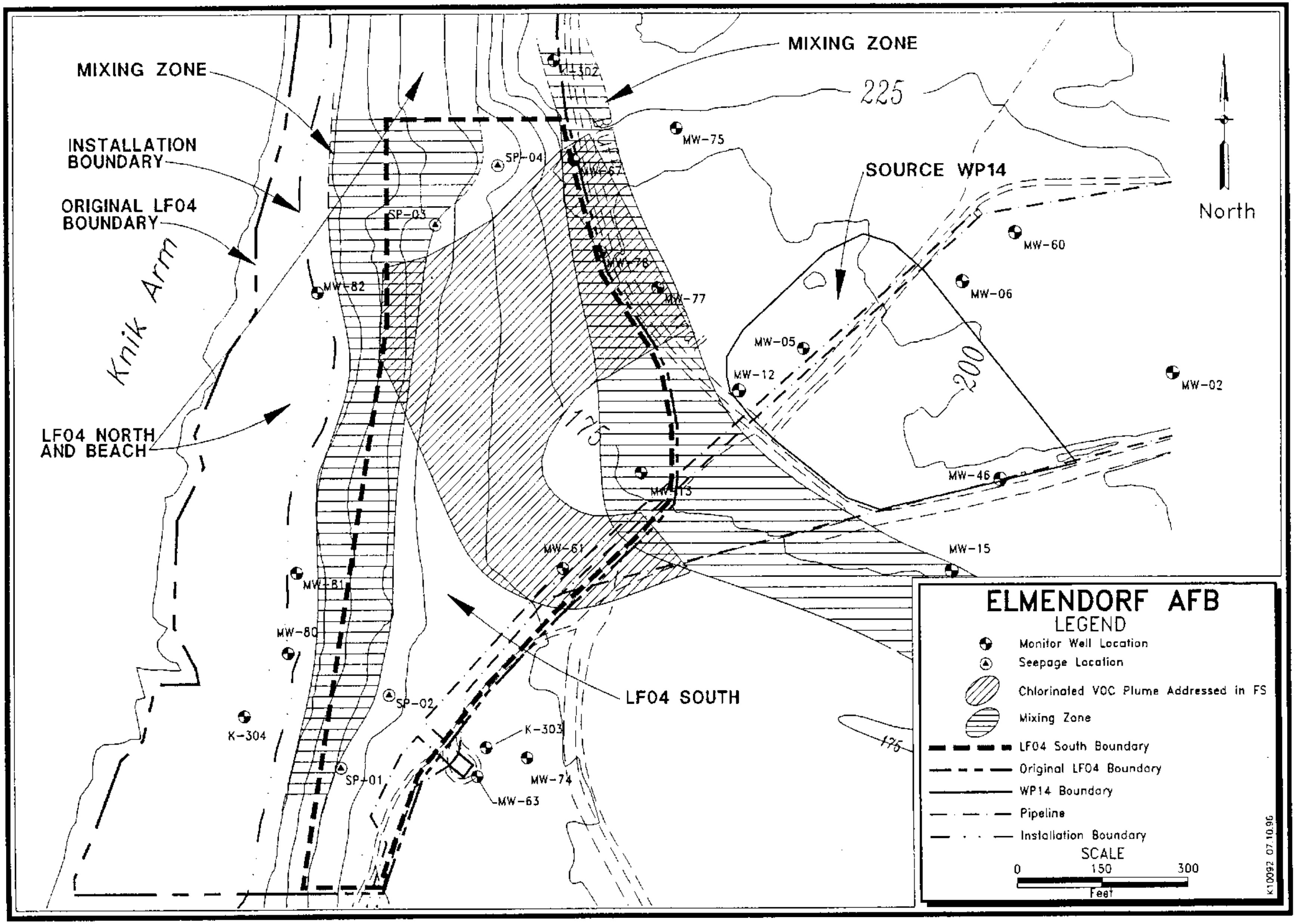


**Figure 3.3-1. Chlorinated Solvent Plume in the Groundwater at LF04**

a COC would have been based entirely on total metals results for turbid samples with corresponding low concentrations in the dissolved phase; and (2) their concentrations did not contribute to significant health risks. Metals at LF04 were also not identified as COCs because their concentrations were comparable to background levels. Additionally, pesticides and dioxins were not included as COCs because these constituents did not significantly contribute to risk.

The Proposed Plan listed DRO, GRO, benzene, and BTEX as soil contaminants with concentrations that exceeded cleanup levels. One area of soil contamination near the pumphouse was addressed as a Compliance project. Tank 790 near the pumphouse at LF04 South (Building 30-790) and the associated contaminated soils were excavated in May 1996. Additionally, the POL line that borders LF04 has been named as a new CERCLA site and will therefore be addressed as a separate project. The remaining areas contained fuel-related contamination in the smear zone which will be addressed as part of the groundwater remedy (see Section 2.3.3).

Pesticides and dioxins were also detected in the soils at LF04. These constituents were not identified as COCs because their contribution to health risk was insignificant. Metals were indentified in the soils at LF04, but they were not indentified as COCs because: (1) their contribution to health risk was insignificant; and (2) their concentration was comparable to background levels. Thus, no chemical-specific COCs were identified for LF04 shallow or deep soils.

Uncovered landfill waste at LF04, particularly debris that has fallen onto the beach, was identified as requiring a response action as part of the remedy for LF04. Debris such as old containers, automotive parts, crushed drums, old piping, etc., are believed to represent a threat to human health or the environment. As a consequence, exposed waste is listed as a COC for the shallow soils at LF04. Since the exposed waste at LF04 is limited to debris on the beach, the north and south division of LF04 was modified such that LF04 North includes the entire beach front (LF04 North/Beach), and LF04 South is limited to the bluff in the southern portion of LF04 only. Accessible debris on the LF04 South bluff face will also be treated the same as the LF04 North/Beach area. This was done to prevent unnecessary duplication of evaluation of alternatives for the landfill waste in both LF04 North and LF04 South. The area of exposed and accessible landfill waste is estimated to be 20 acres.

**Summary**

Actual or threatened releases of hazardous substances from LF04, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment.

## 3.4 Remedial Action Objectives, Alternatives, and Comparative Analysis for LF04

The following subsections discuss the remedial action objectives for LF04, and present a description of the various alternatives which were evaluated to achieve those remedial objectives. The results of the detailed comparison made between those alternatives are also presented. As discussed in Section 3.3, LF04 is divided into two areas, LF04 South and LF04 North/Beach.

### 3.4.1 Remedial Action Objectives

Specific remediation alternatives were developed and evaluated for the areas with potential risk and that exceeded the preliminary remediation goals identified in Section 3.3.3. Specific remedial action objectives (RAOs) for LF04 are as follows:

For LF04 South (bluff groundwater):

- Prevent the ingestion, dermal contact, and inhalation of vapors from groundwater having benzene; toluene; ethylbenzene; 1,2-dichloroethane; and methylene chloride in excess of MCLs and/or resulting in a cancer risk greater than 1.0E-06 or Hazard Index greater than 1.0.

For LF04 North/Beach (beach soils):

- Mitigate human dermal exposure, to the extent practicable, to landfill waste or debris.
- Mitigate exposure, to the extent practicable, of environmentally sensitive receptors to landfill waste. Relevant exposure pathways for wildlife include incidental ingestion of contaminated soil, ingestion of contaminated vegetation, and ingestion of contaminated animals (e.g., insects and earthworms).

As discussed in Section 3.3.3, the soil at LF04 South and the groundwater in LF04 North/Beach have no COCs; thus, RAOs were not developed for these areas.

### 3.4.2 Groundwater Alternatives

As discussed in Sections 3.3.3 and 3.4.1, the bluff groundwater (north of MW-K302) and the beach groundwater do not have any COCs or RAOs. Thus, alternatives were not developed for the LF04 North/Beach groundwater.

As discussed in Section 3.3.3, the primary COCs are HVOCs and fuel constituents in the LF04 South groundwater. In the OU 6 RI/FS, the contaminated groundwater at LF04 South was grouped with the contaminated groundwater at WP14 because: (1) groundwater from WP14 flows directly into LF04 South; (2) the groundwater contains similar COCs; and (3) LF04 South is on an unstable bluff so any extraction wells for this area must be installed upgradient of LF04 South (i.e., on the border between WP14 and LF04 South). Thus, Section 2.4.2 discusses the groundwater alternatives for both WP14 and LF04 South.

### 3.4.3 Summary of Comparative Analysis of Groundwater Alternatives

The comparative analysis describes how each of the groundwater alternatives meet the CERCLA evaluation criteria relative to each other. This analysis is discussed in Section 2.4.3 for both WP14 and LF04 South.

### 3.4.4 Soil Alternatives

The soil at LF04 South (south of MW-K302) does not have any COCs or RAOs (Sections 3.3.3 and 3.4.1); therefore, alternatives were not developed for this area. As discussed in Section 3.3.3, the only COC for LF04 North/Beach soils is the exposed landfill waste. Only two alternatives were evaluated: no action, and annual removal of beach debris.

**Alternative S1: No Action**

Evaluation of this alternative is required by CERCLA as a baseline reflecting current conditions without any cleanup. This alternative is used for comparison with each of the other alternatives. This alternative does not include long-term monitoring, controls, or access restrictions; therefore, potential exposure pathways would not be eliminated. There are no costs associated with this alternative.

**Alternative S2: Annual Removal of Beach Debris**

This alternative includes removing debris that has fallen to the foot of the bluff, or other loose debris which could be collected without impacting the stability of the bluff slope from areas accessible to the necessary equipment. If hazardous materials are encountered during the annual removal events, these materials will be handled appropriately.

Additionally, access to soil would be institutionally controlled. LF04 is currently designated as a "restricted use area" in the Base Comprehensive Plan. This designation provides for recreational use of the parcel (cross country skiing, etc.) and for construction of unmanned facilities such as a parking lot, storage building, or taxiway, but prohibits the construction of any sort of manned facility such as an office building or a residence. As a former landfill, LF04 will maintain this designation indefinitely.

The cost for Alternative S2 is $12,200 for the initial beach sweep and about $9700 for each subsequent beach sweep. The present worth cost for 30 years of removing beach debris is $162,000. The actual remediation time is indefinite. Thirty years of removal was costed, per CERCLA guidance.

### 3.4.5 Summary of Comparative Analysis of Soil Alternatives

Annual removal of beach debris is considered to be the sole practicable remedy. A variety of other alternatives were considered to address the exposed landfill material on the beach, such as capping or stabilization. However, due to the instability of the bluff slope, the overall size of the landfill area, and the fact that tidal action will continually cause slope erosion, remedial actions such as slope capping, excavation, and stabilization were considered impracticable. Annual removal of the landfill debris was considered protective of the human health and the environment since it would prevent the accumulation of excessive debris on the beach and would reduce the chances of contact between the debris and humans or animals. The risks are low at the LF04 beach because of the remoteness of the site and lack receptors.

Annual removal of beach debris is also the best alternative for long-term effectiveness and permanence as well as short-term effectiveness. This alternative would reduce risk to human health and the environment by removing the debris without damaging the stability of the bluff. The risks to on-site workers would be minimal. Additionally, this alternative reduces toxicity, mobility, and volume of the debris by removing it from the site and recycling the metal debris.

Overall, removal of beach debris is considered the sole practicable remedy, because all other options would allow the site conditions to deteriorate (e.g., no action) or would not be implementable or cost effective (e.g., capping, stabilization, or excavation). Thus, removal of beach debris is the most implementable alternative and the most cost-effective action ($162,000).

One ARAR identified for the soils at LF04 is the Alaska Solid Waste Management Regulations, Closure Standards for Municipal Solid Waste Landfills (18 AAC 60.390). To address the final cover requirement of this regulation, the present cover of soil and vegetation, along with annual debris removal, has been approved by ADEC. There is no benefit to the addition of more cover to this site, because the additional weight of the soil would increase the potential for landslides on the bluff. Furthermore, adding cover to the beach soils would be futile, because transport of sand caused by the tides and waves would erode the cover soil as the beach re-establishes an equilibrium with sea level.

The other ARAR identified for LF04 is the off-site disposal rule (40 CFR § 300.440). Any hazardous substances, pollutants, or contaminants identified during the debris removal would be disposed of in accordance with this regulation. Thus, Alternative S2 complies with all ARARs.

## 3.5 Selected Remedy for LF04

The selected remedy for LF04 South groundwater is Alternative G2 (long-term monitoring of groundwater with institutional controls and product removal). The selection process and benefits for this alternative are discussed in Section 2.5.

As discussed in Section 3.3.3 and 3.4.1, LF04 North/Beach groundwater does not have any COCs or RAOs; therefore, no alternatives were evaluated. Additionally, no COCs or RAOs were listed for LF04 South soils, and no alternatives were evaluated. Thus, LF04 North/Beach groundwater and LF04 South soils are recommended for No Further Action.

The selected remedy for LF04 North/Beach soil is annual removal of beach debris ("beach sweeps"). This alternative is the sole practical remedy for mitigating exposure to landfill waste, because it removes the majority of the exposed waste without impacting the stability of the bluff. It is also acceptable to the public and the State of Alaska.

Specific components of the selected remedy are illustrated in Figure 2.5-1 in Section 2.5, and consist of the following:

**Groundwater at LF04 North/Beach:**

- No further action is required for the groundwater at LF04 North/Beach.

**Groundwater at LF04 South:**

- Access to groundwater at LF04 South will be institutionally controlled. LF04 is currently designated as a "restricted use area" in the Base Comprehensive Plan. This designation provides for recreational use of the parcel (cross country skiing, etc.) and for construction of unmanned facilities such as a parking lot, storage building, or taxiway, but prohibits the construction of any sort of manned facility such as an office building or a residence. Drilling into the shallow aquifer is also restricted by the Base Comprehensive Plan. As a former landfill, LF04 will maintain this designation indefinitely.

- Groundwater will be monitored and evaluated annually to determine contaminant migration and to track the progress of contaminant degradation and dispersion, as well as to provide an early indication of unforseen environmental or human health risk. Five-year reviews will also assess the protectiveness of the remedial action, including an evaluation of any changed site conditions, as long as contamination remains above cleanup levels.

- Recoverable quantities of free product found on top of the water table at LF04 will be regularly removed during groundwater monitoring events.

- Groundwater monitoring will be discontinued if contaminant levels are below cleanup levels during two consecutive monitoring events. In that case, no further action for groundwater will be required.

- During the final round of monitoring, samples will be collected and analyzed for all constituents that exceeded MCLs during the 1994 investigation including VOCs, SVOCs, and metals. These results will be evaluated before a final determination is made that groundwater meets all cleanup requirements.

- All groundwater is expected to be cleaned up within 14 years.

**Soil at LF04 North/Beach:**

- Access to soil at LF04 North/Beach will be institutionally controlled. LF04 is currently designated as a "restricted use area" in the Base Comprehensive Plan. This designation provides for recreational use of the parcel (cross country skiing, etc.) and for construction of unmanned facilities such as a parking lot, storage building, or taxiway, but prohibits the construction of any sort of manned facility such as an office building or a residence. As a former landfill, LF04 will maintain this designation indefinitely.

- No further action is required for soil contamination at LF04 North/Beach; however, landfill debris on the beach from LF04 will be removed annually as the specific remedy for this area.

- The removal of debris will include all LF04 landfill material which has fallen onto the beach which can be reasonably collected for disposal, as well as debris on the bluff slope or other low lying areas which can be accessed and removed without hazard.

- Hazardous materials encountered during the annual removal events will be handled according to appropriate regulations.

- The removal of debris from the beach at LF04 is expected to continue annually for 30 years or as long as the landfill remains subject to erosional action by tides. Five-year reviews will assess the protectiveness of the remedial action, including an evaluation of any changed site conditions.

- No further action will be required as a means of closing the LF04 landfill.

**Soil at LF04 South:**

- No further action is required for the soil at LF04 South.

The estimated time for groundwater cleanup is 14 years. Groundwater will be monitored to evaluate the progress of degradation and dispersion. Further response actions, coordinated with the regulatory agencies, may be considered if monitoring finds unacceptable contaminant migration or unacceptable reduction in contaminant concentrations.

The duration of the soil remedy is indefinite. The cost estimate includes 30 years of annual beach sweeps, per CERCLA guidance. Further response actions, coordinated with the regulatory agencies, may be considered if additional contamination is discovered during the annual beach sweeps or if the degree of reduction of debris on the beach is unacceptable.

Because the remedy will result in contaminants remaining on-site, a review will be conducted within 5 years after commencement of remedial action. The review will ensure that the remedy continues to provide adequate protection of human health and the environment. The groundwater cleanup levels (i.e., remediation goals) to be achieved at LF04 are presented in Table 2.5-1.

The selected remedy includes provisions for the preparation of a workplan for continued environmental monitoring of the affected media. This workplan will include specific details regarding the number and location of monitoring points and what will be monitored for, as well as guidelines for eliminating select monitoring points as cleanup occurs. Environmental monitoring will be discontinued at LF04 when the remediation goals have been satisfactorily achieved (Table 2.5-1). This determination will be made jointly by the USAF, the USEPA, and the State of Alaska pursuant to the Federal Facility Agreement.

### 3.5.1 Statutory Determinations

The selected remedy satisfies the requirements under Section 121 of CERCLA to:

- Protect human health and the environment;
- Comply with ARARs;
- Be cost effective; and
- Utilize permanent solutions and alternative treatment technologies to the maximum extent practicable.

Section 2.5.1 discusses how Alternative G2 meets the CERCLA requirements. The following subsections discuss how the beach sweeps satisfy the CERCLA requirements for the LF04 North/Beach soils.

**Protective of Human Health and the Environment**

The selected remedy is protective of human health and the environment. The current risk to human health from the exposed landfill waste is minimal and will be further reduced by removing the waste. Additionally, removal of the debris will protect the environment by preventing it from migrating to Knik Arm.

**Applicable or Relevant and Appropriate Requirements (ARARs)**

**Chemical-Specific ARARs** -- There are no chemical-specific ARARs which must be met for the LF04 North/Beach soils.

**Location-Specific ARARs** -- There are no specific ARARs which must be met because of the location of the contamination and remedial actions at LF04.

**Action-Specific ARARs** -- The Alaska Solid Waste Management Regulations, Closure Standards for Municipal Solid Waste Landfills (18 AAC 60.390) are relevant and appropriate regulations for LF04. To address the final cover requirements of this regulation, the present cover of soil and vegetation, along with annual debris removal, is approved by ADEC. As discussed in Section 3.4.5 there is no benefit to the addition of more cover to this site. The off-site disposal rule (40 CFR § 300.440) is also relevant and appropriate to the selected remedy. Any hazardous substance, pollutant, or contaminant identified during the implementation of the selected remedy will be disposed of in accordance with this regulation. Action-specific ARARs for LF04 are identified in Table 3.5-1.

**Table 3.5-1**

**Identification of Action-Specific ARARs, LF04**
**Elmendorf AFB, AK**

| Standard, Requirement, Criteria, or Limitation | Citation | Description | Documentation |
|---|---|---|---|
| National Oil and Hazardous Substances Pollution Contingency Plan--Off-Site Disposal Rule | 40 CFR § 300.440 | Establishes procedures for planning and implementing off-site transfer of any hazardous substance, pollutant, or contaminant. | Relevant and appropriate if hazardous substances, pollutants or contaminants are transferred off site during implementation of the selected remedy. |
| **State of Alaska** | | | |
| Alaska Solid Waste Management Regulations | 18 AAC 60.390 | Provides requirements for closure of solid waste municipal landfills. | Requirements are relevant and appropriate to the landfill at LF04. |

AAC - Alaska Administrative Code
CFR - Code of Federal Regulations

**Cost Effectiveness**

The remedy is the most cost effective of the alternatives because it affords overall effectiveness proportional to its costs. The no action alternative has no costs, but it does not meet the RAOs.

**Utilization of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable**

The USAF and the USEPA have determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be used in a cost-effective manner at LF04. The State of Alaska concurs with these determinations.

**Preference for Treatment as a Principal Element**

The COC for the LF04 North/Beach soils is exposed landfill waste. Treatment cannot be used to reduce this material; therefore, it will be removed from the site.

### 3.5.2 Documentation of Significant Changes

The Proposed Plan listed soil and groundwater contaminants with concentrations in excess of cleanup goals (ACM guidelines and MCLs). This list was different from the COCs established in Section 3.3.3, because identification of COCs included evaluation of risk along with comparison to cleanup levels. This change was a logical outgrowth of the Proposed Plan and did not affect the choice of alternatives at LF04. Thus, the selected remedy was the preferred alternative presented in the Proposed Plan (Table 7 of the Proposed Plan).

# SECTION FOUR

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# Section 4.0
# SOURCE SD15

The following subsections describe the physical description, land use, groundwater use, and hydrogeology of SD15. The identification of activities which led to the current contamination at SD15 is also included. The discussion of the regulatory and enforcement history of SD15, the role of the response action at SD15, and community participation in the response action are included in the general OU 6 discussion in Section 1.0.

## 4.1 Site Description

Source SD15 is the third of the OU 6 source areas located on the Elmendorf Moraine. This source area is located several thousand feet to the east of Sources LF04 and WP14 at an elevation of approximately 275 feet above mean sea level. This source, which is located off Hubble Road, consists of four separate 30- by 50-foot concrete pads (Figure 4.1-1). The pads were used from the early 1970s to 1983 for weathering fuel filters and pads, and for the disposal of tank sludge. Strong fuel odors, fuel stains on the soil, and fuel filters and pads have been noted at the source area around three of the concrete pads (Pad Nos. 1, 2, and 3). Cracks were also observed in the weathering pads.

During a walk-through survey of this source area conducted in the summer of 1993, a total of 17 old building foundations or concrete pads were noted in the general vicinity. The road was originally cleared to four of these pads to prepare them to be used for weathering and sludge disposal activities. However, available historical information indicates that disposal activities took place at only the first three pads (Pads Nos. 1, 2, and 3). All four pads were investigated during the LFI (USAF, 1993). Based on the results of the LFI sampling effort, and the historical evidence, only the first three pads required further investigation as part of OU 6 (Concrete Pad Nos. 1, 2, and 3 in Figure 4.1-1).

### 4.1.1 Land Use

The land use designation for SD15 is open space in the Base Comprehensive Plan. There are no known historic buildings, archeological sites, wetlands, floodplains, or rare or endangered species at SD15.

### 4.1.2 Hydrogeology and Groundwater Use

The subsurface geology at Source SD15 is relatively complex, as would be expected in glacial moraine deposits. The predominant lithologies encountered include silty sands, sandy and silty gravels, and, to a lesser extent, sandy or gravelly clays. These lithologies are interfingered both horizontally and vertically. Groundwater flow is mainly within these relatively permeable sand and gravel zones and silty sand layers, which are believed to be laterally continuous or, at a minimum, laterally communicating.

Two different aquifer systems were identified at Source SD15 during the 1994 RI: a perched groundwater system, and a deeper unconfined aquifer system. The perched groundwater system was encountered in a relatively localized area at relatively shallow depths (20-45 feet bgs) at Source SD15. The areal extent of the perched zone is depicted in Figure 4.3-1, in Section 4.3, and is based on water level information from both monitoring wells and soil borings drilled during the 1994 RI.

The presence of the perched groundwater zone is probably the result of low permeability deposits which allow for groundwater accumulation to take place. Water levels in monitoring wells completed in the perched groundwater zone were noted to decrease continuously during the summer,

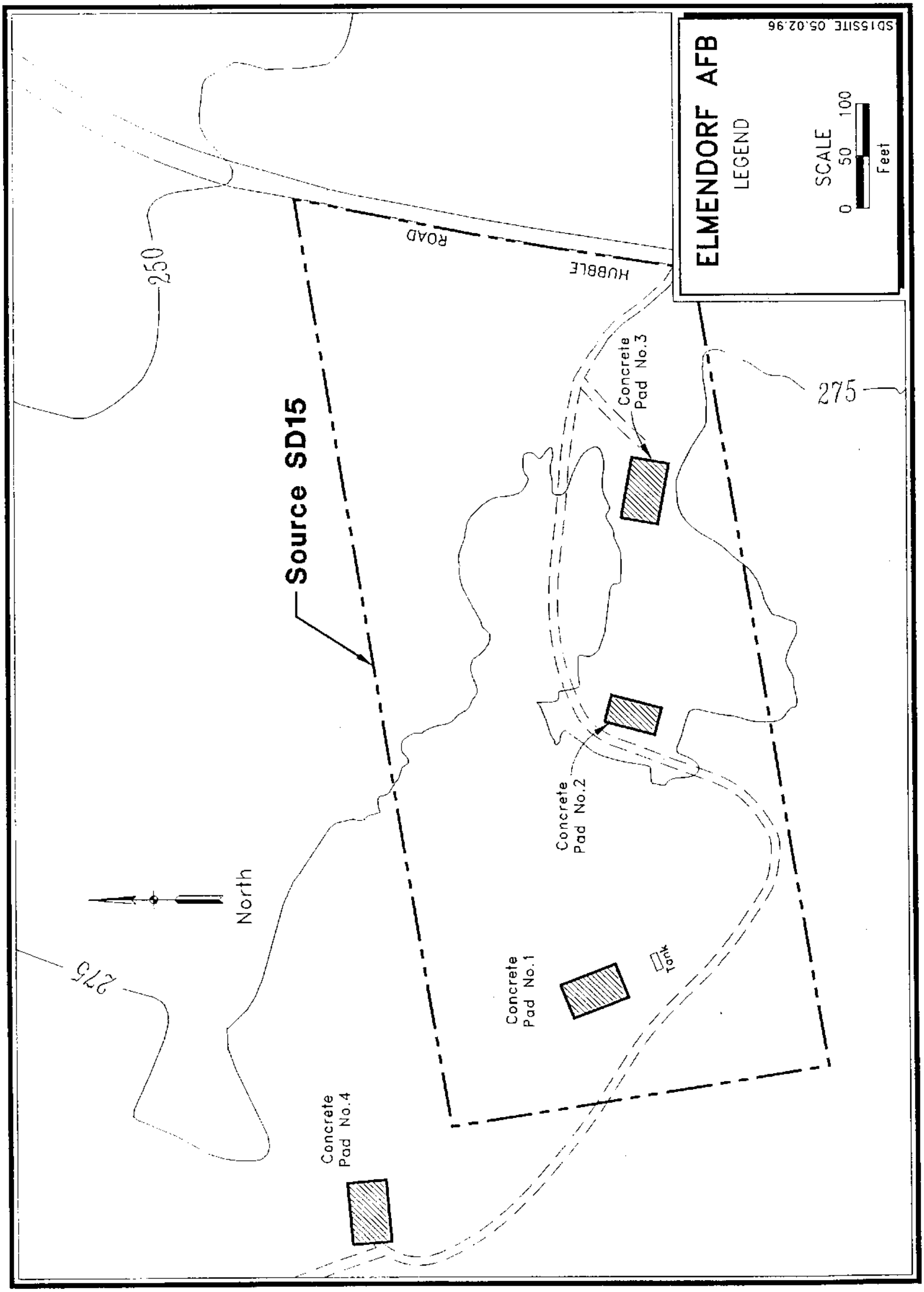


**Figure 4.1-1. Location Map for Source Area SD15**

with one well (MW-28) drying up completely. This could indicate that the perched aquifer is seasonal in nature, and therefore has a variable geometry.

In addition to the shallow wells installed, deeper monitoring wells were also installed at a depth of approximately 115 feet bgs in a regional unconfined aquifer. This deep unconfined aquifer consists of well-graded, sandy gravel. The Bootlegger Cove Formation was not encountered in any of these three deep monitoring wells. This deeper of the two aquifers is believed to correlate with the unconfined shallow aquifer underlying the outwash plain (OUs 3 and 4). Vertical migration between the perched and deeper aquifers at SD15 is possible. However, chemical and modeling results obtained during the RI indicate that downward contaminant migration appears to be insignificant as a result of the vertical distance and the presence of fine grained deposits between the two aquifers.

Groundwater contours generated for the deeper aquifer indicate an almost flat water surface, with a small east-northeast hydraulic gradient of about 10 feet per mile. Groundwater flow in the shallow perched aquifer appears to trend toward the northwest, with a relatively steep hydraulic gradient of approximately 700 feet per mile. While perched aquifers typically tend to have a mound shaped potentiometric surface, a substantial recharge feature, namely a marshy area, was identified upgradient and partially overlying the perched aquifer at SD15. The presence of this recharge area could account for the relatively steep gradient documented within the perched aquifer.

A range in hydraulic conductivity for the shallow aquifer was calculated from slug tests at 2.88E-4 to 4.51E-5 cm/sec. For the deep unconfined aquifer, slug test results indicate high conductivities based on the virtually instantaneous water level recovery in the wells. The range in conductivity values obtained, 1.0E-1 to 1.0E-3 cm/sec, is typical of unconsolidated glacial deposits. A generalized hydrogeologic conceptual model for this area is presented as Figure 4.1-2.

The groundwater in the shallow aquifer, which is believed to correspond with the deeper of the two aquifers encountered at SD15, is not used for any purpose on base. Its future use is generally limited because of the higher yield of the deeper confined aquifer below the Bootlegger Cove Clay. At SD15, the fine-grained nature of the perched aquifer material, coupled with the laterally discontinuous nature of the perched aquifer, would make this aquifer wholly unsuitable as a drinking water supply aquifer.

## 4.2 Site History and Enforcement Activities

The following section identifies the activities which lead to the current contamination at SD15. The regulatory and enforcement history for SD15 is included in the general discussion presented for OU 6 in Section 1.0, as are the discussions of the role of the response action and the community participation in the response.

### 4.2.1 Identification of Activities Leading to the Current Contamination at SD15

Groundwater and soil contamination at SD15 consists primarily of metals, HVOCs, and fuel-related constituents. The source of contamination at SD15 is directly related to the waste management practices conducted in this vicinity. The primary sources for POL contamination at this site are identified as the various spent petroleum products and solvents which were either stored in aboveground tanks, contained in filter elements, or otherwise released onto the cement pad or open ground at Source SD15. Weathering of fuel filters, pads, and tank sludge made both metals and fuels available for leaching into the soil and groundwater. Minimal contamination has reached the deeper aquifer at SD15. Another possible source of contamination at Source SD15 was identified as product loss during removal of contaminated items from the transport vehicles.

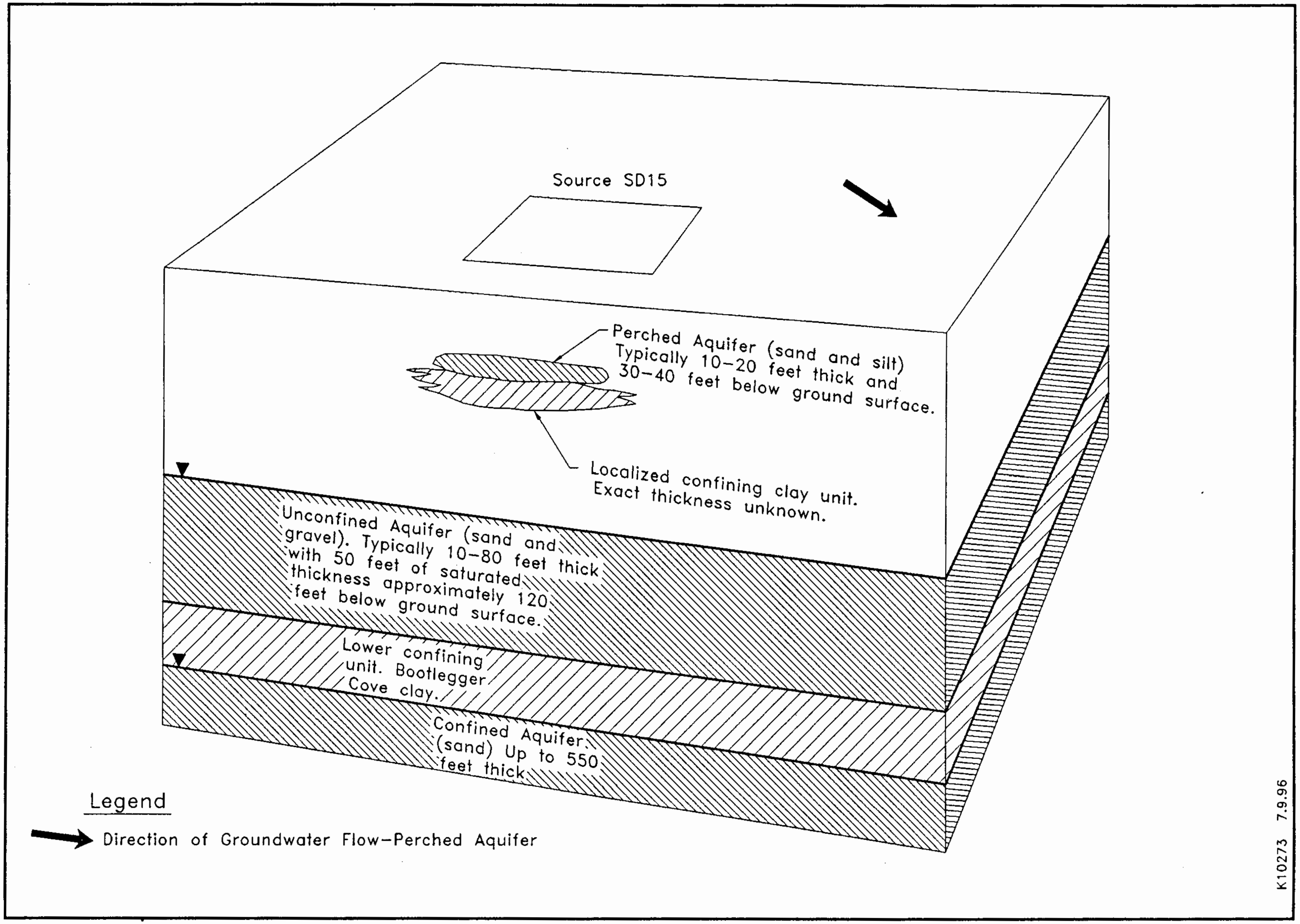


Figure 4.1-2. Conceptual Hydrogeologic Model for SD15



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Soil contamination at SD15 also represents a continuing source for future groundwater contamination via percolation of water through the vadose zone. Downward vertical migration of groundwater from the contaminated upper perched aquifer at SD15 also acts as a contaminant source for the deeper aquifer. Seasonal fluctuations in the water table have also resulted in a smear zone being detected at the base of the vadose zone above the perched aquifer at SD15. A schematic of the potential migration and exposure pathways of fuels and solvents through the soil and into the groundwater is presented in Figure 4.2-1.

Prior to the RI conducted at SD15 in 1994, SD15 had been addressed under the following studies:

- IRP Phase I/II Records Search and Statement of Work (Engineering-Science, 1983);
- IRP Phase II Stage 3 Work Plan (Harding Lawson, 1988);
- RCRA Facility Assessment Report (ADEC, 1988);
- IRP Phase III, Stages 3 and 4, Remedial Investigation/Feasibility Study (Black and Veatch, 1990); and
- OU 7 Limited Field Investigation Work Plan ( USAF 1993b), and Limited Field Investigation Report (USAF, 1993a).

The use of SD15 facilities for the weathering of fuel filters and pads was discontinued in 1983. Weathered fuel filters and two above ground storage tanks in the vicinity of SD15 which could have also acted as potential contaminant sources were removed and disposed of in the summer of 1996.

## 4.3 Site Contamination, Risks, and Areas Requiring Response Actions

This section identifies the areas which were investigated, and those that require remedial action. These areas were chosen based on the risk that contaminants pose to human health and the environment. The basis of this analysis is the data collected during the Remedial Investigation (RI) which identified the nature and extent of contamination at SD15.

### 4.3.1 Nature and Extent of Contamination

During the RI, samples of soil and groundwater were collected and analyzed for organic and inorganic constituents. Significant levels of contaminants were detected in both the soil and groundwater at SD15. These contaminants include fuels and fuel constituents, solvents, metals, and SVOCs. The contamination present at SD15 is associated with contaminant transport in the vadose zone, dissolved aqueous transport, and volatilization. These transport mechanisms are pictorially represented for SD15 in Figure 4.2-1.

Tables 4.3-1 through 4.3-4 list the frequency of occurrence and maximum concentrations of all constituents which were detected during the RI in groundwater and soil. The tables do not include results below the detection limit. The MCLs for groundwater and the ACM guidelines for soil are also listed on the tables for all constituents. Results are separated between "indicator parameters" and "contaminant parameters." Indicator parameters primarily include metals classified as nutrients, and non-speciated fuel constituents such as UDRO which are unsuitable for use in a risk assessment. A detailed discussion of the determination of the COCs for SD15 is presented in Section 4.3.3.

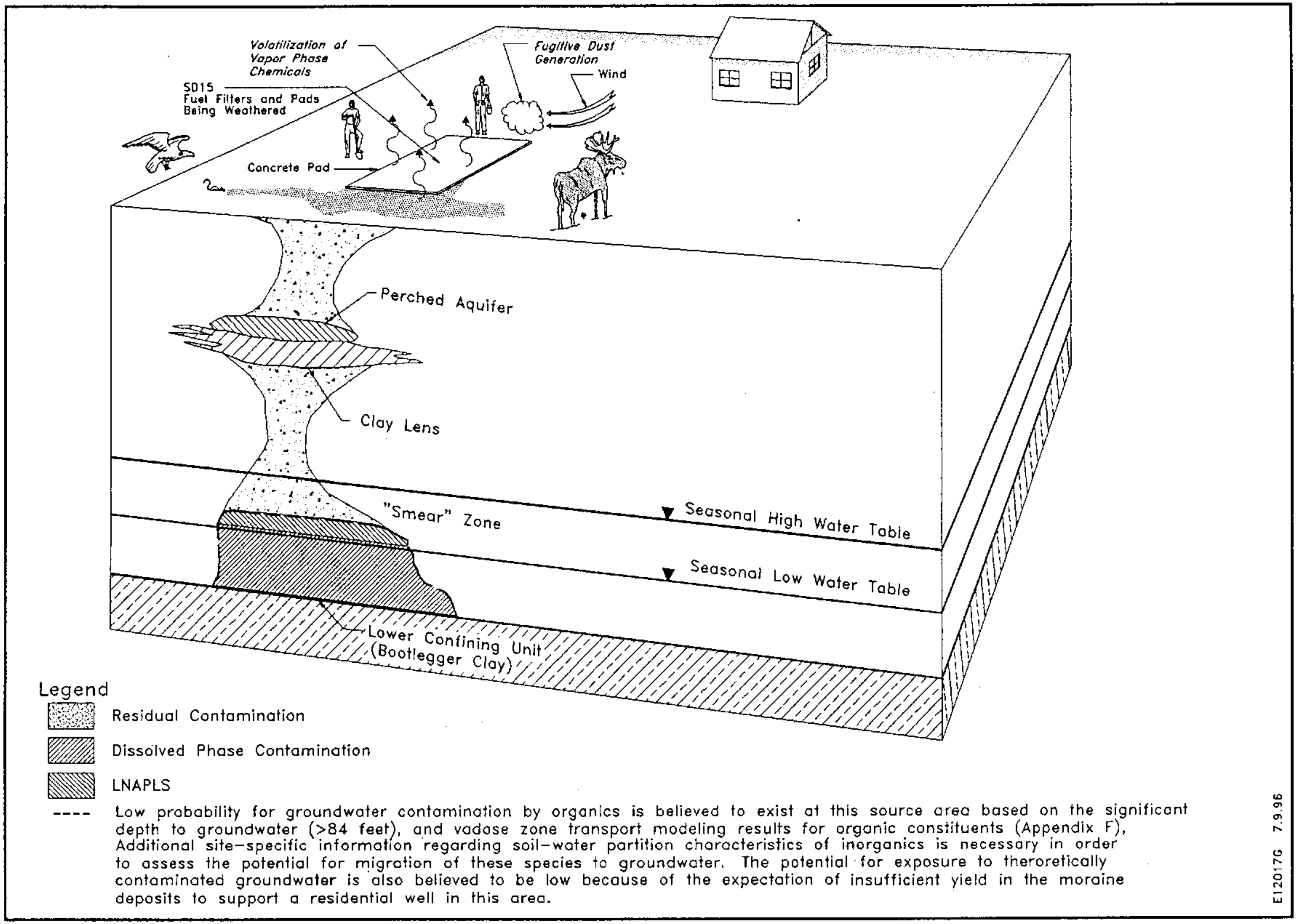


**Figure 4.2-1. Contaminant Release Mechanisms and Potential Pathways for Exposure at SD15**





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## Table 4.3-1

## Summary of Groundwater Analytical Results for the Shallow Perched Aquifer at Source SD15 Elmendorf AFB, AK

| Method (units) | Analyte | MCL[1] | Maximum Result | Frequency of Detections Total Hits/ Total Samples | Location of Maximum Result |
|---|---|---|---|---|---|
| **Indicator Parameters** | | | | | |
| SW8015ME (µg/L) | Unidentified organics [UDRO] | -- | 8490 E | 2/4 | MW-18 |
| SW8015MP (µg/L) | Unidentified organics [UGRO] | -- | 24000 b | 1/4 | MW-18 |
| | Xylene (total) | 10000 | 3940 | 4/4 | MW-18 |
| SW6010, Total (mg/L) | Aluminum | -- | 1.05 | 4/4 | MW-17 |
| | Calcium | -- | 151 | 4/4 | MW-17 |
| | Iron | -- | 10.2 | 4/4 | MW-17 |
| | Magnesium | -- | 32.2 | 4/4 | MW-17 |
| | Potassium | -- | 2.09 | 3/4 | MW-17 |
| | Sodium | -- | 6.25 | 4/4 | MW-18 |
| SW6010, Dissolved (mg/L) | Calcium | -- | 153 | 3/3 | MW-17 |
| | Iron | -- | 8.11 | 3/3 | MW-18 |
| | Magnesium | -- | 33.3 | 3/3 | MW-17 |
| | Potassium | -- | 2.42 | 3/3 | MW-17 |
| | Sodium | -- | 6.33 | 3/3 | MW-18 |
| **Contaminant Parameters** | | | | | |
| SW8015ME (µg/L) | Jet fuel (JP-4) | -- | 8620 | 2/4 | MW-18 |
| SW8015MP (µg/L) | Gasoline | -- | 31700 | 3/4 | MW-18 |
| SW8260 (µg/L) | Acetone | -- | 129 | 4/4 | MW-17 |
| | Benzene | 5 | 1430 | 4/4 | MW-18 |
| | 2-Butanone(MEK) | -- | 17.7 | 4/4 | MW-18 |
| | Chloroethane | -- | 0.2 | 1/4 | MW-18 |
| | Chloroform | 100 | 6.28 | 4/4 | MW-18 |
| | Chloromethane | -- | 4.33 | 4/4 | MW-17 |
| | 1,1-Dichloroethane | -- | 185 | 3/4 | MW-18 |
| | 1,1-Dichloroethene | -- | 2.11 | 4/4 | MW-18 |
| | 1,2-Dichloroethane | 5 | 5.92 | 3/4[2] | MW-18 |
| | cis-1,2-Dichloroethene | 70 | 32.5 | 4/4 | MW-17 |
| | trans-1,2-Dichloroethene | 100 | 0.91 | 4/4 | MW-17 |
| | Ethylbenzene | 700 | 713 | 4/4 | MW-18 |
| | 2-Hexanone | -- | 14.4 | 2/4 | MW-18 |
| | Methylene chloride | 5 | 2.72 B | 4/4 | MW-18 |
| | 4-Methyl-2-pentanone(MIBK) | -- | 28.2 | 4/4 | MW-18 |
| | 1,1,2,2-Tetrachloroethane | -- | 8.6 | 4/4 | MW-18 |
| | Tetrachloroethene | 5 | 0.53 | 3/4 | MW-18 |
| | Toluene | 1000 | 3640 | 4/4 | MW-18 |
| | 1,1,1-Trichloroethane | 200 | 26.2 | 2/4 | MW-18 |
| | 1,1,2-Trichloroethane | 5 | 6.97 | 1/4 | MW-18 |
| | Trichloroethene | 5 | 143 | 4/4 | MW-18 |
| | Vinyl chloride | 2 | 0.31 | 2/4 | MW-18 |
| | m & p-Xylene | -- | 2510 | 4/4 | MW-18 |
| | o-Xylene | -- | 1460 | 4/4 | MW-18 |

**Table 4.3-1**

**(Continued)**

| Method (units) | Analyte | MCL[1] | Maximum Result | Frequency of Detections Total Hits/ Total Samples | Location of Maximum Result |
|---|---|---|---|---|---|
| SW6010, Total (mg/L) | Barium | 2 | 0.0672 | 4/4 | MW-17 |
| | Beryllium | 0.004 | 0.00127 B | 3/4 | MW-18 |
| | Cadmium | 0.005 | 0.00414 B | 1/4 | MW-18 |
| | Chromium | 0.1 | 0.0541 | 2/4 | MW-17 |
| | Cobalt | -- | 0.0238 | 2/4 | MW-18 |
| | Manganese | -- | 14.5 | 4/4 | MW-17 |
| | Nickel | 0.1 | 0.0558 | 2/4 | MW-17 |
| | Zinc | -- | 0.0931 | 4/4 | MW-18 |
| SW7060, Total (mg/L) | Arsenic | 0.05 | 0.065 | 4/4 | MW-17 |
| SW7421, Total (mg/L) | Lead | 0.015 [3] | 0.00231 | 1/4 | MW-17 |
| SW6010, Dissolved (mg/L) | Barium | 2 | 0.0604 | 3/3 | MW-17 |
| | Beryllium | 0.004 | 0.0127 B | 3/3 | MW-17 |
| | Cobalt | -- | 0.0711 | 2/3 | MW-17 |
| | Manganese | -- | 15.5 | 3/3 | MW-17 |
| | Nickel | 0.1 | 0.0201 | 2/3 | MW-18 |
| | Zinc | -- | 0.035 | 3/3 | MW-17 |
| SW7060, Dissolved (mg/L) | Arsenic | 0.05 | 0.0606 | 3/3 | MW-17 |

[1] Maximum contaminant level (MCL); 40 CFR § 141.61 for Federal MCLs, and 18 AAC 80.070 for State MCLs. Federal and State MCLs are identical for the listed constituents.

[2] Frequency "hits" calculation does not include one or more results removed from the data set because they did not meet QA/QC criteria. Total sample count includes all samples analyzed for the indicated parameter.

[3] From 40 CFR, Section 141.11 for inorganics and Section 141.12 for organics (effective 1 July 1991); however, the lead level is effective only until 7 December 1992. There is no longer an MCL for lead or copper (56 Federal Register 26460, June 7, 1991); however, there is an action level of 0.015 mg/L for lead and 1.3 mg/L for copper.

B - Sample concentration was less than or equal to the blank UTL.
E - Analyte concentrations exceeded calibration range.
F - Interference or co-elution suspected.

## Table 4.3-2

## Summary of Groundwater Analytical Results for the Deep Aquifer at Source SD15 Elmendorf AFB, AK

| Method (units) | Analyte | MCL[1] | Maximum Result | Frequency of Detection Total Hits/ Total Samples | Location of Maximum Results |
|---|---|---|---|---|---|
| **Indicator Parameters** | | | | | |
| SW8015ME (µg/L) | Unidentified organics [UDRO] | -- | 31.5 B | 6/6 | MW-71A |
| SW8015MP (µg/L) | Unidentified organics [UGRO] | -- | 40.5 B | 4/6 | MW-72 |
| | Xylene (total) | 10000 | 1.03 | 6/6 | MW-70 |
| SW6010, Total (mg/L) | Aluminum | -- | 0.228 | 5/6 | MW-70 |
| | Calcium | -- | 54.2 | 6/6 | MW-72 |
| | Iron | -- | 0.403 | 6/6 | MW-71A |
| | Magnesium | -- | 7.28 | 6/6 | MW-70 |
| | Sodium | -- | 2.55 | 6/6 | MW-70 |
| **Contaminant Parameters** | | | | | |
| SW8260 (µg/L) | Acetone | -- | 11.3 B | 6/6 | MW-71A |
| | Carbon tetrachloride | 5 | 0.58 | 6/6 | MW-71A |
| | Chloroform | 100 | 0.13 B | 1/6 | MW-71A |
| | Chloromethane | -- | 2.09 B | 6/6 | MW-72 |
| | 1,2-Dichloroethane | 5 | 2.07 B | 5/6[2] | MW-71A |
| | Ethylbenzene | 700 | 0.29 | 5/6 | MW-70 |
| | Methylene chloride | 5 | 2.26 B | 5/6 | MW-71A |
| | Toluene | 1000 | 0.67 | 6/6 | MW-70 |
| | Trichloroethene | 5 | 0.67 | 2/6 | MW-72 |
| | m & p-Xylene | -- | 0.62 | 3/6 | MW-70 |
| | o-Xylene | -- | 0.22 B | 3/6 | MW-70 |
| SW6010, Total (mg/L) | Barium | 2 | 0.011 | 6/6 | MW-72 |
| | Beryllium | 0.004 | 0.00128 B | 3/6 | MW-70 |
| | Chromium | 0.1 | 0.00525 | 1/6 | MW-70 |
| | Manganese | -- | 0.0639 | 6/6 | MW-71A |
| | Zinc | -- | 0.0136 B | 5/6 | MW-72 |
| SW7421, Total (mg/L) | Lead | 0.015[3] | 0.00386 | 1/6 | MW-70 |

[1] Maximum contaminant level (MCL); 40 CFR § 141.61 for Federal MCLs, and 18 AAC 80.070 for State MCLs. Federal and State MCLs are identical for the listed constituents.

[2] Frequency "hits" calculation does not include one or more results removed from the data set because they did not meet QA/QC criteria. Total sample count includes all samples analyzed for the indicated parameter.

[3] From 40 CFR, Section 141.11 for inorganics and Section 141.12 for organics (effective 1 July 1991); however, the lead level is effective only until 7 December 1992. There is no longer an MCL for lead or copper (56 Federal Register 26460, June 7, 1991); however, there is an action level of 0.015 mg/L for lead and 1.3 mg/L for copper.

B - Sample concentration was less than or equal to the blank UTL.

## Table 4.3-3

## Summary of Surface Soil Anayltical Results for Source SD15
## Elmendorf AFB, AK

| Method (units) | Analyte | ACM | Background Upper Tolerance Limit | Maximum Result | Frequency of Detection total hits/ total samples | Location of Maximum Result |
|---|---|---|---|---|---|---|
| **Indicator Parameters** | | | | | | |
| SW9045 (pH units) | pH | -- | -- | 6.22 | 2/2 | SS-072 |
| D2216 (percent) | Percent moisture | -- | -- | 48.2 | 36/36 | SS-078 |
| AK DRO (mg/kg) | Diesel Range Organics | 2000 | -- | 10000 | 4/7 | E7-SS-03 |
| AK GRO (mg/kg) | Gasoline Range Organics | 1000 | -- | 33000 | 3/8 | E7-SS-03 |
| SW8015ME (mg/kg) | Unidentified organics [UDRO] | 2000 | -- | 7210 | 26/29 | SS-075 |
| SW8015MP (mg/kg) | Unidentified organics [UGRO] | 1000 | -- | 11500 | 15/29 | SB-19 |
| SW6010 (mg/kg) | Aluminum | -- | 31183.96 | 26500 | 36/36 | SS-072 |
| | Calcium | -- | 8013.23 | 31200 | 36/36 | SB-19 |
| | Iron | -- | 43192.35 | 28900 | 36/36 | SS-078 |
| | Magnesium | -- | 10904.10 | 8390 | 36/36 | MW-18 |
| | Potassium | -- | 845.75 | 926 | 36/36 | E7-SB-05 |
| | Sodium | -- | 427.05 | 1410 | 36/36 | SB-23 |
| **Contaminant Parameters** | | | | | | |
| SW8010 (μg/kg) | Chloromethane | -- | -- | 28.5 B | 1/8 | E7-SB-04 |
| | Methylene chloride | -- | -- | 76 B | 6/8 | E7-SS-05 |
| | 1,1,2,2-Tetrachloroethane | -- | -- | 97900 | 1/8 | E7-SB-06 |
| | 1,1,1-Trichloroethane | -- | -- | 9260 | 1/8 | E7-SS-03 |
| | Trichloroethene | -- | -- | 1200 P | 2/8 | E7-SB-06 |
| SW8015ME (mg/kg) | Diesel | 2000 | -- | 252 | 2/29 | SB-24 |
| | Kerosene | 2000 | -- | 4210 | 1/29 | SB-19 |
| SW8015MP (μg/kg) | Benzene | 500 | -- | 5.24 B | 1/29 | SS-77 |
| | Ethylbenzene | 10000 | -- | 24600 | 4/29 | SB-19 |
| | Toluene | 10000 | -- | 2370 | 5/29 | SS-75 |
| | Xylene (total) | 10000 | -- | 141000 | 11/29 | SB-19 |
| SW8020 (μg/kg) | Benzene | 500 | -- | 37.9 | 1/8 | E7-SS-05 |
| | Chlorobenzene | -- | -- | 22000 P | 4/8 | E7-SS-03 |
| | 1,2-Dichlorobenzene | -- | -- | 307000 | 4/8 | E7-SS-03 |
| | 1,3-Dichlorobenzene | -- | -- | 165000 | 4/8 | E7-SS-03 |
| | 1,4-Dichlorobenzene | -- | -- | 147000 | 3/8 | E7-SS-03 |
| | Ethylbenzene | 10000 | -- | 51400 | 4/8 | E7-SS-03 |
| | Toluene | 10000 | -- | 34000 | 6/8 | E7-SS-03 |
| | Xylene (total) | 10000 | -- | 594000 | 7/8 | E7-SS-03 |
| SW8240 (μg/kg) | Acetone | -- | -- | 224 | 19/29 | SS-078 |
| | 2-Butanone (MEK) | -- | -- | 8.21 B | 11/29 | SS-078 |
| | Chloroform | -- | -- | 20 | 1/29 | MW-17 |
| | 1,1-Dichloroethene | -- | -- | 10.3 | 2/29 | SS-075 |
| | Methylene chloride | -- | -- | 12.5 | 26/29 | SB-19 |
| | 1,1,2,2-Tetrachloroethane | -- | -- | 11.5 | 1/29 | MW-17 |
| | Tetrachloroethene | -- | -- | 48.2 | 3/29 | SB-19 |

Table 4.3-3

(Continued)

| Method (units) | Analyte | ACM | Background Upper Tolerance Limit | Maximum Result | Frequency of Detection total hits/ total samples | Location of Maximum Result |
|---|---|---|---|---|---|---|
| SW8240 ($\mu$g/kg) (continued) | 1,1,1-Trichloroethane | -- | -- | 66.7 | 1/29 | SS-075 |
| | Trichloroethene | -- | -- | 279 | 2/29 | SB-19 |
| | m & p-Xylene | -- | -- | 122000 | 1/29 | SB-19 |
| | o-Xylene | -- | -- | 55100 | 1/29 | SB-19 |
| SW8270 (mg/kg) | Benzo(a)anthracene | -- | -- | 0.0226 | 1/7 | E7-SB-04 |
| | Benzo(a)pyrene | -- | -- | 0.0274 | 1/7 | E7-SB-04 |
| | Benzo(b)fluoranthene | -- | -- | 0.056 F | 1/7 | E7-SB-04 |
| | Benzo(g,h,i)perylene | -- | -- | 0.0274 | 1/7 | E7-SB-04 |
| | Benzo(k)fluoranthene | -- | -- | 0.056 F | 1/7 | E7-SB-04 |
| | bis(2-Ethylhexyl)phthalate | -- | -- | 2.23 | 6/7 | E7-SS-04 |
| | Dibenz(a,h)anthracene | -- | -- | 0.0105 J | 1/7 | E7-SB-05 |
| | Fluoranthene | -- | -- | 0.0244 | 1/7 | E7-SB-04 |
| | Indeno(1,2,3-cd)pyrene | -- | -- | 0.0244 | 1/7 | E7-SB-04 |
| | Pyrene | -- | -- | 0.0223 | 1/7 | E7-SB-04 |
| SW6010 (mg/kg) | Antimony | -- | NA | 10.3 | 19/36 | SS-072 |
| | Arsenic | -- | 13.27 | 13.7 | 4/7 | E7-SS-05 |
| | Barium | -- | 196.45 | 8420 | 7/7 | E7-SS-04 |
| | Beryllium | -- | 0.76 | 0.352 | 35/36 | SS-078 |
| | Cadmium | -- | 2.68 | 1.59 | 2/7 | E7-SS-05 |
| | Chromium | -- | 48.44 | 35.8 | 36/36 | MW-18 |
| | Cobalt | -- | 19.52 | 12.1 | 36/36 | SS-078 |
| | Copper | -- | 31.67 | 72.1 | 36/36 | SS-077 |
| | Lead | -- | 10.69 | 139 | 7/7 | E7-SB-05 |
| | Manganese | -- | 929.98 | 717 | 36/36 | MW-28 |
| | Molybdenum | -- | -- | 2.43 | 36/36 | SB-19 |
| | Nickel | -- | 50.68 | 35.2 | 7/7 | E7-SS-02 |
| | Selenium | -- | 0.54 | 12.5 | 13/36 | SS-075 |
| | Vanadium | -- | 101.64 | 76.4 | 36/36 | SS-072 |
| | Zinc | -- | 90.01 | 138 | 7/7 | E7-SS-04 |
| SW7060 (mg/kg) | Arsenic | -- | 13.27 | 13.2 | 29/29 | SS-072 |
| SW7421 (mg/kg) | Lead | -- | 10.69 | 72.6 | 29/29 | SS-065 |

ACM - Alaska Cleanup Matric, Level D.
B - Sample concentration was less than or equal to the blank UTL.
F - Co-elution or interference was suspected.
J - Result is less than sample specific detection limit. Data with this flag should be interpreted with caution.
NA - Not applicable.
P - Analyte quantitation not confirmed. Results from primary and secondary GC columns differ by greater than a factor of three.



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## Table 4.3-4

## Summary of Subsurface Soil Analytical Results for Source SD15
## Elmendorf AFB, AK

| Method (units) | Analyte | ACM[1] Guideline | Background Upper Tolerance Limit | Maximum Result | Depth of Maximum Result (ft.) | Frequency of Detection Total Hits/ Total Samples | Location of Maximum Result |
|---|---|---|---|---|---|---|---|
| **Indicator Parameters** | | | | | | | |
| SW9045 (pH units) | pH | -- | -- | 7.94 | 36 | 1/1 | SB-21 |
| D2216 (percent) | Percent moisture | -- | -- | 22.9 | 36 | 95/95 | MW-18 |
| AK DRO (mg/kg) | Diesel Range Organics | 2000 | -- | 6000 | 9 | 6/15 | E7-SB-03 |
| AK GRO (mg/kg) | Gasoline Range Organics | 1000 | -- | 21000 | 4.5 | 6/15 | E7-SB-01 |
| SW8015ME (mg/kg) | Unidentified organics [UDRO] | 2000 | -- | 17.8 | 35.75 | 29/31 | MW-18 |
| SW8015MP (mg/kg) | Unidentified organics [UGRO] | 1000 | -- | 1490 | 4 | 21/33 | SB-24 |
| SW6010 (mg/kg) | Aluminum | -- | 18116.77 | 18600 | 4 | 47/47 | E7-SB-06 |
| | Calcium | -- | 10264.39 | 18400 | 50 | 47/47 | SB-25 |
| | Iron | -- | 38483.64 | 96400 | 25 | 47/47 | E7-SB-03 |
| | Magnesium | -- | 14784.34 | 9820 | 36 | 47/47 | SB-19 |
| | Potassium | -- | 1114.35 | 1330 | 30.5 | 47/47 | MW-18 |
| | Sodium | -- | 365.59 | 249 | 30.5 | 47/47 | MW-18 |
| **Contaminant Parameters** | | | | | | | |
| SW8010 ($\mu$g/kg) | cis-1,2-Dichloroethene | -- | -- | 105 | 36 | 1/15 | E7-SB-01 |
| | 1,1-Dichloroethane | -- | -- | 881 | 4.5 | 2/15 | E7-SB-01 |
| | Methylene chloride | -- | -- | 174 B | 44 | 9/15 | E7-SB-02 |
| | 1,1,2,2-Tetrachloroethane | -- | -- | 918 | 21 | 4/15 | E7-SB-06 |
| | Tetrachloroethene | -- | -- | 66.6 | 16 | 2/15 | E7-SB-04 |
| | 1,1,1-Trichloroethane | -- | -- | 7740 | 4.5 | 3/15 | E7-SB-01 |
| | Trichloroethene | -- | -- | 1740 | 21 | 11/15 | E7-SB-06 |
| SW8015ME (mg/kg) | Diesel | 2000 | -- | 29.4 | 11 | 1/31 | SB-24 |
| | Kerosene | 2000 | -- | 19.9 | 16 | 1/31 | SB-19 |
| SW8015MP ($\mu$g/kg) | Benzene | 500 [2] | -- | 420 | 28 | 9/33 | MW-17 |
| | Gasoline | 1000000 | -- | 11700 | 46 | 1/33 | MW-18 |
| | Ethylbenzene | -- [2] | -- | 1540 | 36 | 7/33 | SB-23 |
| | Tolune | -- [2] | -- | 1780 | 36 | 10/33 | SB-23 |
| | Xylene (total) | -- [2] | -- | 10700 | 4 | 10/33 | SB-24 |
| SW8020 ($\mu$g/kg) | Benzene | 500 [2] | -- | 11900 | 4.5 | 6/15 | E7-SB-01 |
| | Chlorobenzene | -- | -- | 11400 P | 4.5 | 4/15 | E7-SB-01 |
| | 1,2-Dichlorobenzene | -- | -- | 18500 P | 4.5 | 7/15 | E7-SB-01 |
| | 1,3-Dichlorobenzene | -- | -- | 5110 | 9 | 2/15 | E7-SB-05 |
| | 1,4-Dichlorobenzene | -- | -- | 15500 P | 4.5 | 3/15 | E7-SB-01 |
| | Ethylbenzene | -- [2] | -- | 62000 | 4.5 | 9/15 | E7-SB-01 |
| | Toluene | -- [2] | -- | 135000 | 4.5 | 10/15 | E7-SB-01 |
| | Xylene (total) | -- [2] | -- | 138000 | 20 | 10/15 | E7-SB-03 |

# Table 4.3-4

## (Continued)

| Method (units) | Analyte | ACM[1] Guideline | Background Upper Tolerance Limit | Maximum Result | Depth of Maximum Result (ft.) | Frequency of Detection Total Hits/ Total Samples | Location of Maximum Result |
|---|---|---|---|---|---|---|---|
| SW8240 ($\mu$g/kg) | Acetone | -- | -- | 40.1 B | 28 | 26/33 | MW-17 |
| | 2-Butanone (MEK) | -- | -- | 26.6 B | 36 | 14/33 | MW-18 |
| | Chloroform | -- | -- | 153 | 28 | 4/33 | MW-17 |
| | 1,1-Dichloroethene | -- | -- | 26.4 | 36 | 4/33 | MW-18 |
| | cis-1,2-Dichloroethane | -- | -- | 26.7 | 36 | 4/33 | SB-23 |
| | Methylene chloride | -- | -- | 19.6 | 46 | 26/33 | SB-21 |
| | 4-Methyl-2-pentanone (MIBK) | -- | -- | 2.35 B | 46 | 1/33 | MW-18 |
| | 1,1,2,2-Tetrachloroethane | -- | -- | 8.24 | 36 | 1/33 | MW-17 |
| | Trichloroethene | -- | -- | 181 | 36 | 8/33 | MW-17 |
| | m & p-Xylene | --[2] | -- | 1260 | 36 | 7/33 | MW-18 |
| | o-Xylene | --[2] | -- | 678 | 36 | 7/33 | MW-18 |
| SW8270 (mg/kg) | Acenaphthene | -- | -- | 0.0249 | 16 | 1/16 | E7-SB-01 |
| | bis(2-Ethylhexyl)phthalate | -- | -- | 0.211 | 16 | 8/16 | E7-SB-05 |
| | Butylbenzylphthalate | -- | -- | 0.403 | 9 | 1/16 | E7-SB-05 |
| | Dibenzofuran | -- | -- | 0.0120 J | 20 | 1/16 | E7-SB-03 |
| | Fluorene | -- | -- | 0.0197 | 20 | 2/16 | E7-SB-03 |
| | 2-Methylnaphthalene | -- | -- | 9.87 | 9 | 6/16 | E7-SB-03 |
| | 2-Methylphenol (o-cresol) | -- | -- | 0.0471 | 16 | 1/16 | E7-SB-01 |
| | 4-Methylphenol (p-cresol) | -- | -- | 0.106 F | 16 | 1/16 | E7-SB-01 |
| | Naphthalene | -- | -- | 2.47 | 9 | 5/16 | E7-SB-03 |
| | Phenol | -- | -- | 0.0448 | 21 | 1/16 | E7-SB-01 |
| SW6010 (mg/kg) | Antimony | -- | NA | 12.2 | 30.5 | 5/47 | MW-18 |
| | Arsenic | -- | 9.31 | 12.1 | 6 | 9/47 | E7-SB-04 |
| | Barium | -- | 95.93 | 661 | 9 | 47/47 | E7-SB-03 |
| | Beryllium | -- | 0.64 | 0.341 | 25 | 47/47 | E7-SB-03 |
| | Cadmium | -- | 3.07 | 1.3 | 25 | 9/47 | E7-SB-03 |
| | Chromium | -- | 76.94 | 46.2 | 26 | 47/47 | SB-21 |
| | Cobalt | -- | 17.62 | 16.5 | 25 | 47/47 | E7-SB-03 |
| | Copper | -- | 59.84 | 84.7 | 41 | 47/47 | E7-SB-01 |
| | Lead | -- | 10.13 | 56.2 | 16 | 47/47 | E7-SB-05 |
| | Manganese | -- | 709.45 | 1770 | 46 | 47/47 | SB-20 |
| | Molybdenum | -- | NA | 2.39 | 25 | 47/47 | E7-SB-03 |
| | Nickel | -- | 71.79 | 48.4 | 36 | 47/47 | SB-19 |
| | Selenium | -- | 0.48 | 37.9 | 25 | 33/47 | E7-SB-03 |
| | Silver | -- | 1.06 | 0.638 | 6 | 1/47 | E7-SB-04 |
| | Vanadium | -- | 66.16 | 64.2 | 30.5 | 47/47 | MW-18 |
| | Zinc | -- | 76.17 | 79.4 | 9 | 47/47 | E7-SB-03 |
| SW7060 (mg/kg) | Arsenic | -- | 9.31 | 9.83 | 46 | 31/31 | SB-19 |
| SW7421 (mg/kg) | Lead | -- | 10.13 | 7.69 | 4 | 31/31 | MW-18 |

[1] Alaska Cleanup Matrix (ACM) Level D; 18 AAC 78.315.
[2] The ACM Level D guideline for benzene, toluene, ethylbenzene, and xylenes (BTEX) combined is 100,000 $\mu$g/kg.
B - Sample concentration was less than or equal to the blank UTL.
F - Co-elution or interference was suspected.
NA - Not applicable.
P - Analyte quantitation not confirmed. Results from primary and secondary GC columns differ by greater than a factor of three.



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**Groundwater Contamination at SD15**

Groundwater data at SD15 was characterized as two distinct aquifers based on the hydrogeology. The groundwater data were separated into groundwater results from the perched aquifer (Table 4.3-1) and groundwater results from the deeper aquifer (Table 4.3-2). The predominant type of groundwater contamination detected at SD15 includes fuel constituents, solvents and other VOCs, and metals. The difference in levels of contamination between the perched aquifer and deeper aquifer at SD15 is substantial, with the deeper aquifer showing only minor levels of contaminants and fewer contaminant species.

The perched aquifer results at SD15 indicated elevated levels of BTEX and fuel constituents, with a maximum benzene concentration of 1430 $\mu$g/L in a sample from monitoring well MW-18 (Table 4.3-1). This well had the highest levels of other fuel constituents as well, including gasoline, jet fuel, UDRO, UGRO, and other BTEX constituents. A recurring accumulation of several inches of free phase floating product was also identified in this well. Solvent contamination is also present at SD15, with a maximum detection of 143 $\mu$g/L for trichloroethene at MW-18. Other volatile organic compounds were detected at substantially lower concentrations.

Numerous metals were also detected in the perched groundwater at SD15. These include relatively low concentrations of barium, beryllium, cadmium, chromium, cobalt, manganese, nickel, and zinc (Table 4.3-1). As at other OU 6 source areas, a statistical comparison of these metals concentrations was made to available background metals concentration from the *Elmendorf Air Force Base, Alaska, Basewide Background Sampling Report* (USAF, 1993). Based on this evaluation, all metals evaluated in both the aquifers at SD15 were determined to be at or near background concentrations. The summary statistics for the USGS data, including the upper confidence limit concentrations used for these comparisons, are presented in Table 2.3-4.

Metals, VOCs, and fuels were detected in the groundwater collected from the deeper aquifer at SD15 (Table 4.3-2). All concentrations were significantly lower than those from the perched aquifer, with most of the maxima from constituents being detected at or near the levels found in the laboratory blank samples ("B" flagged), and the bulk of the remainder detected at concentrations below 1.0 $\mu$g/L. Metals were also detected, but after the comparison to background metals, these were determined to be at background concentrations.

**Soil Contamination at SD15**

Soil data from SD15 were evaluated based upon surface and subsurface contaminant occurrences. Surface soils include all soils collected from depths shallower than 3 feet bgs. Subsurface soils are those collected from below 3 feet. Tables 4.3-3 and 4.3-4 list the sample depths, maximum concentrations, locations, and guidelines associated with the ACM for non-UST soil for all contaminant parameters in the surface and subsurface soil samples at SD15. Results below the detection limits are not included in the analytical summary tables.

The contaminants present in the surface soil at SD15 consist primarily of fuels, weathered fuel residuals, solvents, and metals. Fuel components and metals were the most pervasive contaminants. BTEX constituents were detected at a maximum of 594,000 $\mu$g/kg in surface sample E7-SS-03. Other fuels constituents, such as unidentified gasoline range organics (UGROs), were also detected at substantially elevated concentrations. Benzene concentrations were lower in the surface soils than in the subsurface soils; however, concentrations of solvents appear to be slightly higher. SVOCs were only detected sporadically in the surface soils (Table 4.3-3).

Contamination in the subsurface soils at SD15 were of generally similar types and concentrations to those of the subsurface. Significant concentrations of BTEX (benzene at 11,900 $\mu$g/kg, toluene at 135,000 $\mu$g/kg, ethylbenzene at 62,000 $\mu$g/kg, and xylene at 138,000 $\mu$g/kg) were detected in the subsurface soils (Table 4.3-4). Other fuels constituents, such as UGRO, were also detected at elevated levels in (1490 mg/kg). SVOCs and solvents were detected at significantly lower levels in the subsurface soils.

Metals were identified in both surface and subsurface soils at SD15. The metals detected were determined to be predominantly at or near background concentrations. The background results used in the metals evaluation at SD15 are included in the soil analytical tables (Tables 4.3-3 and 4.3-4). Analytical results from the basewide background sampling event (USAF, 1993) were pooled into surface and subsurface soil results, and were used as the basis to conduct statistical comparisons with on-site results.

### 4.3.2 Risk Evaluation

Based on the concentrations of contaminants detected during the RI, human health and environmental risk assessments were performed to determine if areas should be considered for remedial action. All concentrations of contaminants, including all contaminants of concern, whether exceeding MCLs or ACM guidelines or not, were included in the risk assessments. The general discussion of the human health and ecological risk assessment procedures is presented in Section 2.3.2, and will not be repeated since the procedures for each of the source areas within OU 6 were identical. Details on the parameters used in the Health Risk Assessment are shown on Table 2.3-5.

**Human Health Risk Assessment (HRA)**

Since SD15 is not currently used residentially, a *current* residential risk scenario was not evaluated, and only current visitor and trench worker scenarios were applied. Even though the future land use at SD15 is limited as specified in the Base Comprehensive Plan, the *future* residential risk scenario was evaluated to obtain the most conservative risk information possible.

ELCRs and HIs were calculated to describe cancer and noncancer risks, respectively. The ELCR is the additional chance that an individual exposed to site contamination will develop cancer during his/her lifetime. It is expressed as a probability such as 1.0E-06 (one in a million). The HI estimates the likelihood that exposure to the contamination will cause some negative health effect. An HI score above one indicates that some people exposed to the contamination may experience at least one negative health effect.

The calculated risks at SD15 are based on hypothetical exposure to soil and groundwater. Groundwater risk at SD15 was calculated separately for the perched aquifer and the deeper aquifer. The shallow groundwater aquifers at SD15 are not presently used, and will not be used in the future for supplying potable or non-potable water. For carcinogenic soil risk, the calculated results for the future resident (RME), construction worker, and visitor are listed. Only the future resident scenario (RME) was used to calculate carcinogenic groundwater risk. Table 4.3-5 summarizes the calculated carcinogenic and noncarcinogenic human health risks calculated for SD15.

Cancer risk using the residential RME scenario for the groundwater in the perched aquifer at SD15 exceeds 1.0E-03. As at LF04 and WP14, benzene is the predominant risk driver, with several solvents contributing significantly as well. Noncarcinogenic risk for the perched aquifer is 25.1, with toluene and ethylbenzene as the primary contributors. Carcinogenic risk in the deeper aquifer only slightly exceeds 1.0E-06, due exclusively to carbon tetrachloride. Noncarcinogenic risk is below 1.0.

## Table 4.3-5

## Summary of Human Health Risks at SD15
## Elmendorf AFB, AK

| Risk | Surface Soil (<3 feet) | | Subsurface Soil | Chemical(s) Driving Risk |
|---|---|---|---|---|
| | Residential Scenario[a] | Visitor Scenario[b] | Trench Worker Scenario[c] | |
| **Soil Risk [d]** | | | | |
| Carcinogenic | 1.6E-05 | 1.0E-06 | <1.0E-06 | Arsenic |
| Non-Carcinogenic | 2.1 | 0.13 | NR | Arsenic, Manganese |
| **Perched Groundwater Risk [d]** | | | | |
| Carcinogenic | 2.7E-03 | NA | NA | Benzene, 1,1,2-Trichloroethane, 1,1,2,2-Tetrachloroethane, Trichloroethene, 1,2-Dichloroethane, Chloroform, Chloromethane, Vinyl Chloride |
| Non-Carcinogenic | 25.1 | NA | NA | 1,1,2-Trichloroethane, Trichloroethene, Chloroform, Toluene, Ethylbenzene |
| **Deep Groundwater Risk [d]** | | | | |
| Carcinogenic | 19.E-06 | NA | NA | Carbon tetrachloride |
| Non-Carcinogenic | 0.44 | NA | NA | Carbon tetrachloride |

[a] Excess cancer risks conservatively assumed for 30 years of exposure (drinking groundwater, contact with soil, etc.) by future residents (Reasonable Maximum Exposure).
[b] Excess cancer risks conservatively assumed for 30 years of exposure while visiting the site under current conditions.
[c] Excess cancer risks conservatively assumed for 1 year of exposure during on-site construction work (digging, etc.).
[d] Risks are calculated by using the 95% upper confidence limits (UCLs) for contaminants present unless the 95% UCL exceeded the maximum concentration detected, in which case the maximum concentration was used. This represents a conservative estimate of the "worst case" contamination.
NA - Not applicable.
NR - Significant risk not identified.

Shallow soil carcinogenic RME risk at SD15 only slightly exceeded 1.0E-06 for both the RME and visitor scenarios. Only the RME noncarcinogenic risk exceeded 1.0. No significant risk was identified under the trench worker scenario. Soil risk was 100% attributable to metals, which are believed to be at background concentrations.

**Ecological Risk Assessment (ERA)**

The ERA was performed to determine if the reported concentrations of chemicals or calculated exposures to plants and wildlife at OU 6 are likely to produce adverse effects. Ecological effects were evaluated quantitatively by calculating Ecological Quotients (EQs). The ERA focused on evaluating potential impacts of the contamination on selected indicator species: the moose, masked shrew, meadow vole, black-capped chickadee, merlin, and peregrine falcon. The general discussion of the ecological risk assessment procedures is presented in Section 2.3.2 and will not be repeated since the procedures for each of the source areas within OU 6 were identical.

Calculated EQs exceeded 1.0 for the black capped chickadee, shrew and meadow vole at SD15 due to elevated levels of barium. The highest EQ equals 18000 and is associated with barium for the black capped chickadee, followed by 4700 and 160, also for barium for the masked shrew and meadow vole, respectively. The 95% UCL for the surface soil barium concentration is influenced by two isolated high barium results obtained during the OU 7 LFI in 1993 (661 mg/kg and 8420 mg/kg). Such high barium concentration were not observed in any of the samples collected during the 1994 RI. It therefore appears that the high barium concentrations are associated with a localized anomaly and that barium is not a significant contributor to ecological risk in the area. The EQ for the shrew was also exceeded for selenium concentrations. Three organic constituents, benzo(a)anthracene, bis(2-ethylhexyl)phthalate, and dibenz(a,h)anthracene also caused EQ exceedances for the black capped chickadee and the shrew. The highest organic EQ was 5.1 for benzo(a)anthracene in the black capped chickadee. EQs were calculated based on surface soil contaminant concentrations. None of the calculated EQs exceeded 1.0 for the moose, peregrine falcon, or merlin at SD15.

**Uncertainties Associated with the Risk Assessment**

The major assumptions and uncertainty factors for the OU 6 human health and ecological risk assessments are presented in Section 2.3.2.

### 4.3.3 Conclusions

The following subsections provide a discussion of the determination of COCs for SD15, the location and extent of contamination by COCs in excess of preliminary cleanup goals, and a summary statement about the risk to public health, welfare, or the environment if action is not taken at SD15.

**Contaminants of Concern**

Constituents exceeding preliminary remediation goals (MCLs for groundwater or ACM guidelines for soil) were identified in the Proposed Plan. COCs were developed from the results of the risk assessment and by considering preliminary remediation goals. Each constituent having an individual contribution of greater than 1.0E-06 carcinogenic (RME) risk, or an HI greater than 0.1 when the cumulative HI for the site is greater than 1.0, was considered as a COC. In addition, any constituent exceeding preliminary remediation goals (MCLs for groundwater or ACM guidelines for soil) was also considered as a COC. The final COCs for SD15 are shown on Table 4.3-6, with the individual risk contributed and basis for identifying the COC (risk or regulatory standard).

Seven COCs were identified for the perched groundwater at SD15 (Table 4.3-6). All of the COCs contribute to excess risk. All of the constituents except 1,1,2,2-tetrachloroethane were also identified as COCs due to the exceedance of MCLs. Thus, all COCs except 1,1,2,2-tetrachloroethane were identified in the Proposed Plan as having exceeded regulatory guidelines. It is believed that most of the perched aquifer at SD15 is contaminated, and that a groundwater plume of dissolved fuel and solvent contamination is present over much of the site. The volatile organic plume at SD15 is depicted as Figure 4.3-1. This map is drawn based upon concentrations exceeding 5 $\mu$g/L, which is the MCL for benzene and trichloroethene. The estimate volume of contaminated groundwater is 975,000 gallons.

One metal, arsenic, also exceeded MCLs. Arsenic was not identified as a COC because: (1) the maximum concentration was determined to be statistically below background levels; (2) the result from only a single sample was only slightly over the MCL; and (3) arsenic was not identified as a risk driver for groundwater.

The COCs identified for soil at SD15 are consistent with those contaminants listed in the Proposed Plan as having exceeded regulatory guidelines. Three COCs were identified in the soils at SD15, including GRO, DRO, and BTEX. These constituents exceeded preliminary remediation goals at multiple locations. These are graphically represented in Figure 4.3-2. Several areas of both shallow (less than 5 feet bgs) and deep (greater than 5 feet bgs) soil contamination requiring cleanup are identified in the figure. The estimated volume of contaminated soil is 650 cubic yards.

Metals were also detected in the soils at SD15. These constituents were not identified as COCs because: (1) their contribution to health risk was insignificant; (2) their concentration contributed to health risk but was below potential cleanup levels; or (3) their concentration was comparable to background levels.

**Summary**

Actual or threatened releases of hazardous substances from SD15, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment.

## 4.4 Remedial Action Objectives, Alternatives, and Comparative Analysis for SD15

The following subsections discuss the remedial action objectives for SD15, and present a description of the various alternatives which were evaluated to achieve those remedial objectives. The results of the detailed comparison made between those alternatives are also presented.

### 4.4.1 Remedial Action Objectives

Specific remediation alternatives were developed and evaluated for the areas with potential risk, and that exceeded the preliminary remediation goals identified in Section 4.3.3. Specific remedial action objectives for SD15 are as follows:

- Prevent the domestic use (i.e., use resulting in ingestion and dermal contact of water, and inhalation of vapors) of water in the perched aquifer having benzene; ethylbenzene; toluene; 1,1,2,2-tetrachloroethane; 1,1,2-trichloroethane; 1,2-dichloroethane; and trichloroethene in excess of MCLs and/or resulting in a cancer risk greater than 1.0E-06, or a Hazard Index greater than 1.0.

- Prevent the possible migration of contaminants from soils having DRO, GRO, and BTEX concentrations exceeding ACM Level D.

# Table 4.3-6

## Summary of Contaminants of Concern[1] at SD15
## Elmendorf AFB, AK

| Chemical | Maximum Concentration | Maximum Cancer Risk | Maximum Hazard Index | Basis for COC | Remediation Goal | Basis for Remediation Goal |
|---|---|---|---|---|---|---|
| **Groundwater (Perched Aquifer):** | | | | | | |
| Benzene | 1430 μg/L | 2.5E-03 | -- | Exceeds MCL; contributes to a risk > 1.0E-06 | 5 μg/L | MCL |
| Ethylbenzene | 713 μg/L | -- | 2.7 | Exceeds MCL; contributes to HI > 1 | 700 μg/L | MCL |
| Toluene | 3640 μg/L | -- | 20 | Exceeds MCL; contributes to HI > 1 | 1000 μg/L | MCL |
| 1,1,2,2-Tetrachloroethane | 8.60 μg/L | 9.6E-05 | -- | Contributes to a risk > 1.0E-06 | --[2] | -- |
| 1,1,2-Trichloroethane | 6.97 μg/L | 2.2E-05 | <0.1 | Exceeds MCL; contributes to a risk > 1.0E-06 | 5 μg/L | MCL |
| 1,2-Dichloroethane | 5.92 μg/L | 3.0E-05 | -- | Exceeds MCL; contributes to a risk > 1.0E-06 | 5 μg/L | MCL |
| Trichloroethene | 143 μg/L | 6.8E-05 | 2.0 | Exceeds MCL; contributes to a risk > 1.0E-06; contributes to HI > 1 | 5 μg/L | MCL |
| **Shallow Soils (0-5 feet bgs):** | | | | | | |
| GRO | 33,000 mg/kg | -- | -- | Exceeds ACM Level D | 1000 mg/kg | ACM Level D |
| DRO | 10,000 mg/kg | -- | -- | Exceeds ACM Level D | 2000 mg/kg | ACM Level D |
| BTEX | 168 mg/kg | -- | -- | Exceeds ACM Level D | 100 mg/kg | ACM Level D |

## Table 4.3-6

## (Continued)

| Chemical | Maximum Concentration | Maximum Cancer Risk | Maximum Hazard Index | Basis for COC | Remediation Goal | Basis for Remediation Goal |
|---|---|---|---|---|---|---|
| **Deep Soils (>5 feet bgs):** | | | | | | |
| GRO | 5200 mg/kg | -- | -- | Exceeds ACM Level D | 1000 mg/kg | ACM Level D |
| DRO | 6000 mg/kg | -- | -- | Exceeds ACM Level D | 2000 mg/kg | ACM Level D |

[1] Cancer risk ≥ 1.0E-06 or HQ ≥ 0.1 for soil or groundwater scenario with a total HQ of ≥ 1.0; or concentrations found in excess of regulatory levels. If cancer risk or HQ did not exceed standards, it was marked as "--".

[2] 1,1,2,2-Tetrachloroethane does not have an MCL; therefore, there is no remediation goal. Cleanup will be considered complete when all other COCs meet MCLs.

MCL - Maximum Contaminant Level (40 CFR § 141.61 for Federal MCLs; 18 AAC 80.070 for State MCLs). Federal and State MCLs are identical for the COCs.
ACM - Alaska Cleanup Matrix, Level D (18 AAC 78.315)
bgs - Below ground surface
BTEX - Benzene, toluene, ethylbenzene, and xylenes
COC - Contaminant of Concern
DRO - Diesel range organics
GRO - Gasoline range organics

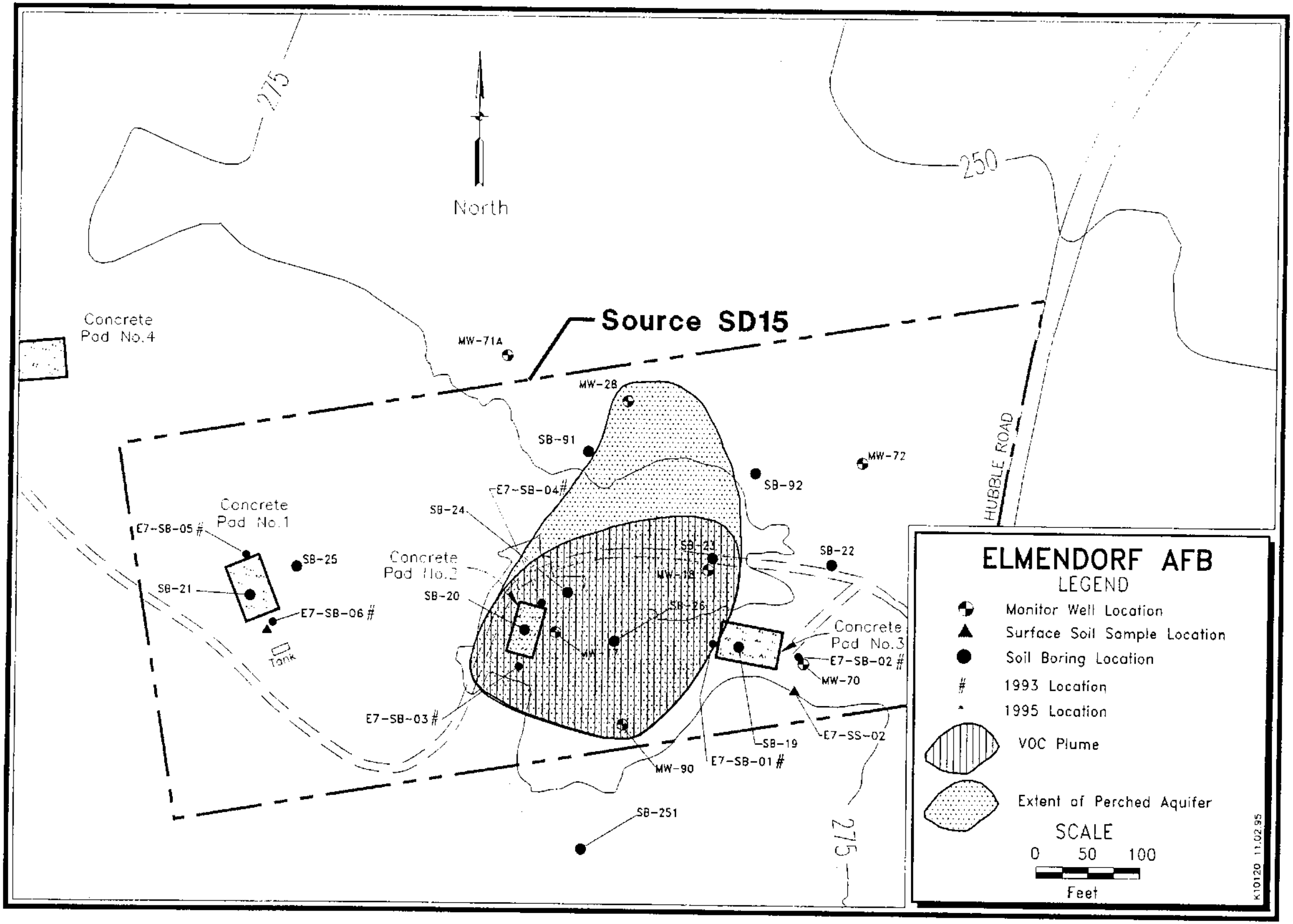


Figure 4.3-1. Fuel and Chlorinated Solvent Plume in the Groundwater at SD15

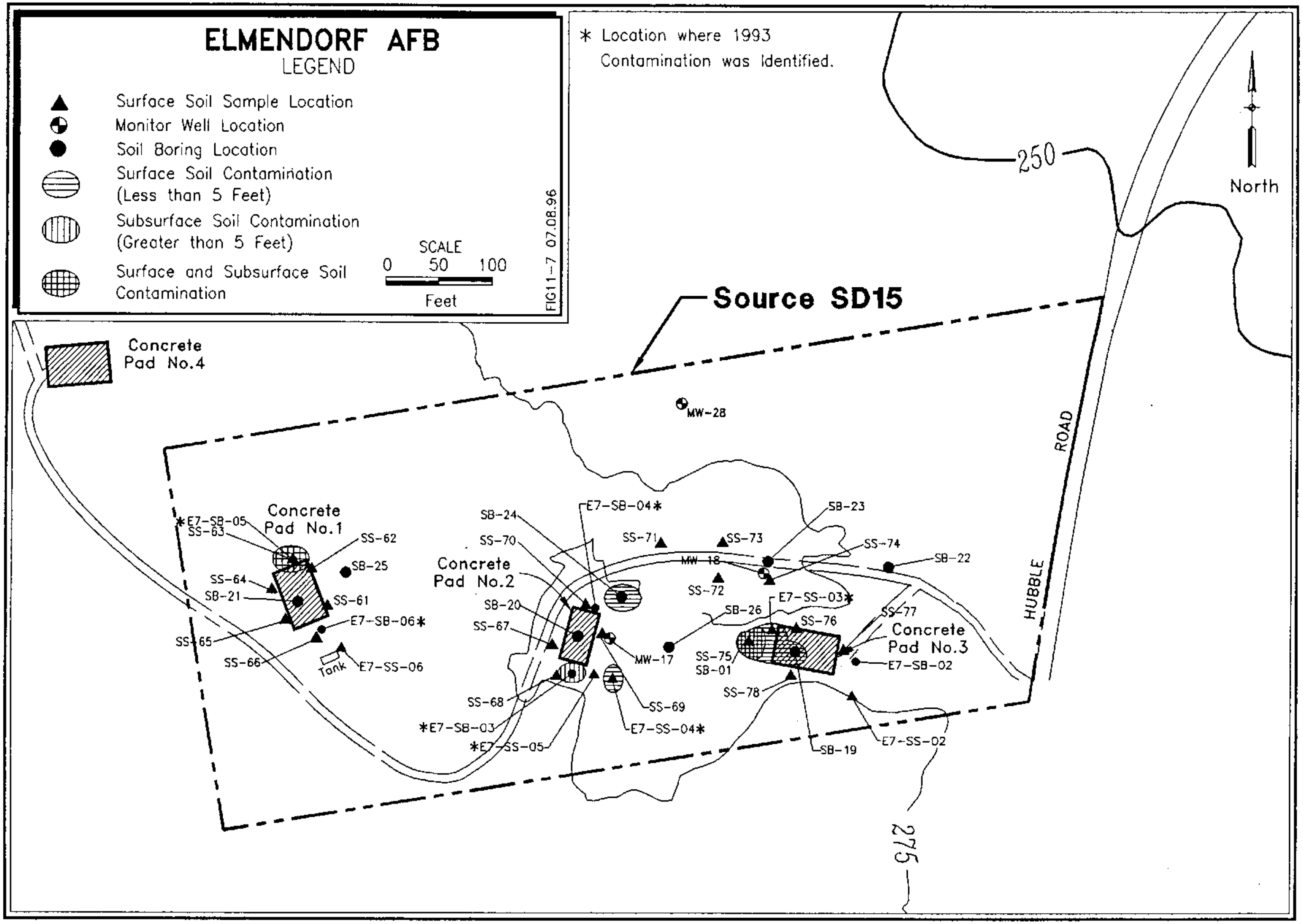


Figure 4.3-2. Areas of Soil Contamination at SD15





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### 4.4.2 Groundwater Alternatives

As discussed in Section 4.3.3, the primary groundwater COCs for SD15 are HVOCs and fuel constituents. Cleanup alternatives were developed separately for groundwater and soil; therefore, the development of alternatives was segregated accordingly. The four most promising groundwater alternatives ("G") were chosen on the basis of the nine CERCLA criteria. These included the following: no action (G1); long-term monitoring with institutional controls and product recovery (G2); pump and treat with institutional controls and long-term monitoring (G3); and high-vacuum extraction with institutional controls and long-term monitoring (G4). Descriptions of the four groundwater alternatives, methods for determining the time to complete cleanup, and an explanation of the cost estimations are included in Section 2.4.2. The groundwater alternatives for SD15 are similar to those for WP14/LF04 South, except that air stripping would be not be included as part of Alternative G3. Also, extracted groundwater would be reinjected into the deep aquifer for Alternatives G3 and G4. Table 4.4-1 summarizes the cleanup times and cost estimates for the groundwater alternatives at SD15.

### 4.4.3 Summary of Comparative Analysis of Groundwater Alternatives

The comparative analysis describes how each of the groundwater alternatives meet the CERCLA evaluation criteria relative to each other. The groundwater alternatives for SD15 are similar to those for WP14/LF04 South. Section 2.4.3 contains a comparative analysis of these alternatives. The comparative analysis for SD15 differs from that for WP14/LF04 South in that the plume at SD15 is contained in small perched aquifer; therefore, active treatment is more feasible from a technical implementation and cost standpoint. WP14/LF04 South has a wide spread plume in a non-homogeneous aquifer and arduous and unstable togography (i.e., the bluff) that makes installation of an active treatment system difficult and costly.

Another difference between WP14/LF04 South and SD15 is in the length of time until cleanup is complete. Table 4.4-1 shows the remediation times and costs for SD15. The time to cleanup affects the short-term effectiveness criterion. However, the order of preference for short-term effectiveness for SD15 would remain the same as for WP14, because for both sites G4 has the shortest remediation time followed by G2 and G3. The costs for SD15 also follow the same trend as for WP14.

**Cost**--Alternative G1 does not have any costs associated with it. The next least expensive alternative is G2 ($328K), followed by G4 ($912K) and G3 ($1,280K). All costs are in present value.

**State Acceptance**--The State of Alaska has been involved in the development of the alternatives for SD15 and concurs with the USAF and the USEPA in the selection of Alternative G4, high-vacuum extraction with institutional controls and long-term monitoring, for groundwater at SD15. The USAF will investigate and implement other remedial alternatives should the selected remedy prove to be unsuccessful at meeting the required cleanup levels.

**Community Acceptance**--All of the alternatives were presented to the public in the Proposed Plan. Based on the comments received during the public comment period, the public has no preference of alternatives.

### 4.4.4 Soil Alternatives

As discussed in Section 4.3.3, the primary COCs for SD15 are fuel constituents in the soils. The five most promising soil alternatives ("S") were chosen on the basis of the nine CERCLA criteria. These included the following: no action (S1); institutional controls with intrinsic remediation

## Table 4.4-1

### Costs and Time to Cleanup for Groundwater Alternatives, SD15
### Elmendorf AFB, AK

| Alternative | Costs (Thousands of $) | | | Time to Cleanup (years) |
|---|---|---|---|---|
| | Capital | Annual O&M [a] | Present Value [b] | |
| G2 | 1.71 | 34.7 | 328 | 12.7 |
| G3 | 621 | 71.3 | 1280 | 12.7 |
| G4 | 528 | 93.9 | 912 | 4.8 |

[a] O&M - Operation and maintenance
[b] Present value discount rate 5%

## Table 4.4-2

### Costs and Time to Cleanup for Soil Alternatives, SD15
### Elmendorf AFB, AK

| Alternative | Costs (Thousands of $) | | | Time to Cleanup Shallow Soils (years) | Time to Cleanup Deep Soils (years) |
|---|---|---|---|---|---|
| | Capital | O&M [a] | Present Value [b] | | |
| S2 | 1.71 | 34.7 [c] | 535 | 50 | 24 |
| S3 | 157 | 22.3 [c] | 470 | 0.25 | 24 |
| S4 | 247 | 45.6 | 479 [d] | 0.25 | 12 |
| S5 | 292 | 46.6 | 524 [e] | 0.25 | 12 |

[a] O&M - Operation and maintenance
[b] Present value discount rate = 5%
[c] Annual cost for years that sampling is conducted. For Alternative S3, the O&M cost for those years that sampling is not conducted is $3490. This includes the cost of maintaining the cap for 30 years, per CERCLA guidance.
[d] The cost of excavating and thermal treating surface soils (without bioventing) is about $42,000 with no O&M costs.
[e] The cost of excavating and composting surface soils (without bioventing) is about $87,000 with no O&M costs.


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(ICIR) and long-term monitoring (S2); capping with ICIR and long-term monitoring (S3); excavation, thermal treatment, and backfilling for shallow soils and bioventing for deep soils (S4); and excavation, composting, and backfilling for shallow soils and bioventing for deep soils (S5).

Time to complete cleanup for intrinsic remediation (S2 and S3) and composting (S5) was calculated using first order decay, with the most conservative published values of half-lives for the primary contaminant of concern. The remediation time for bioventing was calculated using biodegradation rates attained from bioventing treatability studies conducted at Elmendorf AFB. In both cases, conservative degradation rates were assumed because hydrocarbon concentrations are low (i.e., low food source).

Except for the no action alternative, the cost of each alternative includes monitoring of soil for the estimated time period to complete cleanup, up to a maximum of 30 years, in accordance CERCLA guidance. Net present value cost was calculated using a 5% discount rate. Costs estimates were calculated using the USAF RACER system and have an accuracy of -30 to +50 percent.

The alternatives are as follows:

**Alternative S1: No Action**
There are no costs associated with this alternative.

Evaluation of this alternative is required by CERCLA as a baseline reflecting current conditions without any cleanup. This alternative is used for comparison with each of the other alternatives. It does not take into consideration future events such as intrinsic remediation; however, intrinsic remediaton is expected to occur. As a result, cleanup levels are expected to be achieved within the same time frame as the intrinsic remediation alternative (50 years for SD15). This alternative does not include long-term monitoring, controls, or access restrictions; therefore, potential exposure pathways would not be eliminated and future degradation would not be monitored.

**Alternative S2: Institutional Controls with Intrinsic Remediation and Long-term Monitoring**
Costs and time to cleanup for this alternative are presented in Table 4.4-2.

Soil would be remediated by natural processes (physical, chemical, and biological) that reduce contaminant concentrations. Soil chemical properties at SD15 are expected to eventually attenuate the fuel contamination. Low temperatures and competition between contaminants could slow biodegradation of organic contaminants. Contaminants at SD15 should degrade to regulatory levels within 50 years. While intrinsic remediation is working, existing land use restrictions would be used to limit access to contaminated soil. Land use restrictions are part of the Base Comprehensive Plan. These controls would prohibit construction of residences and prohibit excavation of soil in areas of soil contamination that exceed acceptable levels. The USAF would monitor soil quality annually, until cleanup levels are achieved. If there is any indication that intrinsic remediation is not achieving the cleanup levels within the expected time frames, the remedial actions would be reevaluated and additional action taken if necessary.

**Alternative S3: Capping for Shallow Soils and Institutional Controls, Intrinsic Remediation, and Long-Term Monitoring for Deep Soils**
Costs and time to cleanup for this alternative are presented in Table 4.4-2.

Alternative S3 includes installing a multi-layer cap over areas of shallow soil contamination. These areas would be cleared and grubbed. Clean fill would be placed and compacted over the areas of contamination to establish the necessary grade for drainage. The cap would include an impervious layer (synthetic liner), a drainage layer (sand, drainage fabric, and filter fabric), and a vegetative soil cover. The cap would effectively immobilize and therefore contain soil contaminants in the unsaturated zone by reducing infiltration. Land use restrictions would be implemented to protect the integrity of the cap.

Capping would be ineffective for deep soils. Rainwater could infiltrate around the edges of the cap. Also, the cap is not needed to prevent human dermal exposure or ecological exposure to deep soils. Therefore, institutional controls and intrinsic remediation with long-term monitoring, as described under Alternative S2 would be implemented for those areas with only deep soil contamination. The deep soils have less contamination than the shallow soils; therefore, intrinsic remediation would take 24 years for the deep soils.

**Alternative S4: Excavation, Thermal Treatment, and Backfilling for Shallow Soils and Bioventing for Deep Soils**

Costs and time to cleanup for this alternative are presented in Table 4.4-2.

Alternative S4 includes excavating the contaminated shallow soils and transporting them to a commercial recycling facility in the Anchorage area for treatment using low-temperature thermal desorption. The excavated soils would be treated and returned to the site to backfill the excavation pits. Confirmation samples would be collected to ensure that remediation is complete.

Alternative S4 also includes bioventing for the contaminated deep soils. In bioventing, air is injected into the soils to increase the oxygen content. By increasing the oxygen content of the soil gas, bioventing increases aerobic degradation of the contaminants by naturally occurring microorganisms.

**Alternative S5: Excavation, Composting, and Backfilling for Shallow Soils and Bioventing for Deep Soils**

Costs and time to cleanup for this alternative are presented in Table 4.4-2.

Alternative S5 includes excavating contaminated shallow soils, creating a compost pile at the site, treating the soils until acceptable levels are reached, and backfilling the excavations with the treated soils. An HDPE liner and soil pad would be constructed near the site of the excavation. Bulking agents, nutrients, and water would be added to the contaminated soil to provide optimal conditions for biological degradation of the fuel contaminants. In addition, the composted soil would be turned regularly using heavy equipment. Soil from the pile would be sampled periodically to determine the progress of the remediation. Alternative S5 also includes bioventing for the contaminated deep soils as described under Alternative S4. Thus, Alternatives S4 and S5 differ from each other only as far as how to remediate the shallow contaminated soil.

### 4.4.5 Summary of Comparative Analysis of Soil Alternatives

The comparative analysis describes how each of the soil alternatives meet the CERCLA evaluation criteria relative to each other.



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**Threshold Criteria**

Threshold criteria are those that must be met for the alternative to be viable and relate directly to the statutory findings discussed in Section 4.5.1. This category includes two criteria: overall protection of human health and the environment, and compliance with ARARs.

**Overall Protection of Human Health and the Environment**--Alternative S1 (No Action) was the only alternative that failed to meet this criterion, because the RAO concerning prevention of migration of contamination was not satisfied, and access by visitors to the site was not restricted.

Two alternatives partially met this criterion: Alternatives S2 and S3. These alternatives protect human health and the environment, but it would require 50 years for S2 and 24 years for S3 to meet ARARs during which time the migration of contaminants could occur. The potential for migration is mitigated to a degree by soil capping in Alternative S3. Given the probable age of the contamination, and the fact that monitoring to detect contaminant migration would occur as part of both alternatives, the incremental increase in protectiveness offered by a cap would not likely offset the ecological impact caused by capping, and the associated installation and maintenance costs.

As active treatments, Alternatives S4 and S5 provide the greatest protection to human health and the environment. These alternatives fully meet this criterion since each contribute to the reduction of contaminants through active treatment. The only difference between them is the treatment technology for excavated shallow soils, which does not affect their protectiveness of human health and the environment. After excavation and treatment of shallow soils, clean soil would be returned to the excavations. This would occur in less than one year, rather than the 50 years needed for shallow soils in Alternatives S2. Bioventing of deep soils would increase aerobic degradation and effectively reduce the fuel contamination to acceptable levels in 12 years as opposed to the 24 years for deep soils with Alternatives S2 and S3. Environmental impacts caused by excavation could be mitigated through revegetation.

**Compliance with ARARs**--Alternative S1 is the only alternative which does not meet this criterion. While intrinsic remediation is expected to occur, this process cannot be documented without taking action via sampling. This alternative therefore cannot comply with ARARs.

Each of Alternatives S2, S3, S4, and S5 equally meet this criterion, since each provides for the timely reduction of contaminants to levels below ARARs. For chemical-specific ARARs, the only difference between the alternatives is the time it would take to reduce contaminant levels to below ARARs. For Alternatives S2 and S3, ARARs would be met in approximately 50 and 24 years, respectively. For Alternatives S4 and S5, ARARs would be met in approximately 12 years; therefore, Alternatives S4 and S5 comply more quickly with ARARs.

No location-specific ARARs have been identified for SD15. Each alternative equally meets the action-specific ARARs. The off-site disposal rule would have to be factored into the disposal of excavated soils.

**Balancing Criteria**

Balancing criteria are the primary basis for comparing alternatives. These criteria relate the alternative to the site-specific conditions. The no action alternative (S1) is not evaluated based on the balancing criteria or the modifying criteria, since it did not meet the threshold criteria. Balancing criteria includes long-term effectiveness and permanence; reduction in toxicity, mobility, and volume through treatment; short-term effectiveness; implementability; and cost.

**Long-term Effectiveness and Permanence**--This criterion has to do with long-term protection of human health and the environment (reduction of risks), and adequacy and reliability of controls. Long-term management ("controls") would include a 5-year review, land use restrictions, and annual soil sampling. Of these four alternatives, S4 and S5 best meet this criterion, because these alternatives require no long-term maintenance or monitoring following execution. S4 meets this criterion somewhat more completely than S5, since the compost pile associated with shallow soil treatment in alternative S5 may contribute to a somewhat greater degree of residual risk. Between Alternatives S2 and S3, Alternative S2 meets this criterion slightly more completely than Alternative S3, since minimal maintenance would be required on the soil cap. Institutional controls in place in Alternative S2 would provide adequate and reliable controls for preventing exposure to shallow soil contamination.

**Reduction in Toxicity, Mobility, and Volume Through Treatment**--Although intrinsic remediation will reduce the toxicity and volume of contaminants, Alternatives S2 and S3 do not meet this criterion, because intrinsic remediation and capping are not treatment alternatives. Alternatives S4 and S5 both fully meet this criterion, since both are active treatment alternatives which will effectively reduce contaminant toxicity, mobility, and volume over time.

**Short-term Effectiveness**--This criterion evaluates risks to workers, the community, and the environment during the period of time until remedial action objectives are met. Alternatives G2, G3, and G4 each meet this criterion since each provides adequate protection and risk reduction while soil contaminants are being reduced to acceptable levels. While risks posed to workers or the public would be minimal for both alternatives during implementation, the time frame for achieving RAOs for Alternatives S2 and S3 is substantially longer than for Alternatives S4 and S5. Community protection would be imposed through institutional controls during implementation. Since capping mitigates the potential for exposure to contaminated soils, and also mitigates the potential for contaminates migrating into the groundwater, Alternative S3 meets this criterion more fully than Alternative S2. Both Alternative S4 and S5 fully meet this criterion. Community exposure to risks during implementation would be minimal. Worker exposure would be mitigated through institutional controls and normal safety precautions. Environmental impacts would be mitigated via revegetation.

**Implementability**--Each of the four alternatives fully meet this criterion since each are considered fully implementable at SD15. Alternative S2 is considered the most implementable, since this alternative involves no construction or excavation, only routine sampling. Alternatives S3, S4 and S5 are considered equally implementable from the standpoint of having reliable technologies and available equipment and specialists. Because Alternative S3 does not readily allow additional remedial action to be taken if necessary, it is considered the least implementable of the soil alternatives. Of the remaining two alternatives (S4 and S5), S4 is considered the most easily implemented, since the on-site construction of a treatment facility would not be required in S4, and the timing of the remedial action with respect to weather (for the functionality of the compost pile) would not be as critical.

**Cost**--Alternative S1 does not have any costs associated with it. The next least expensive alternative is S3 ($470K), followed by S4 ($479K), S5 ($524K), and S2 ($535K). All costs are in present value.

**Modifying Criteria**

Modifying criteria consider state and community concerns.

**State Acceptance**--The State of Alaska has been involved in the development of alternatives for SD15 and concurs with the USAF and the USEPA in the selection of excavation, thermal treatment, and backfilling (Alternatives S4) for the contaminated shallow soils at SD15. As discussed in Section 4.4.3, high-vacuum extraction is selected for remediation of the groundwater. This technology will also remediate the deep soil contamination at SD15; therefore, bioventing is not included in Alternative S4 for SD15.

**Community Acceptance**--All of the alternatives were presented to the public in the Proposed Plan. Based on the comments received during the public comment period, the public has no preference of alternatives.

## 4.5 Selected Remedy for SD15

The selected remedy for SD15 includes Alternative G4 for groundwater and deep soils (high-vacuum extraction with institutional controls and long-term monitoring) and Alternative S4 for shallow soils (excavation, thermal treatment, and backfilling). The selected remedy is hereafter referred to as Alternative G4/S4. This remedy best meets the nine CERCLA criteria. It protects human health and the environment, and complies with ARARs. It is effective at reducing contamination both in the short term and long term, and is implementable, cost-effective, and acceptable to the public and the State of Alaska. This alternative provides an appropriate level of treatment to reduce risks and comply with ARARs. Modeling showed that cleanup can occur within a reasonable time (5 years for groundwater and deep soils, less than 1 year for shallow soils). The known sources of contamination have been controlled, so they are no longer a threat. High-vacuum extraction will extract contaminated groundwater, free product, and contaminated soil vapors from the subsurface at a fast rate. Contaminants will be removed from the groundwater, and the groundwater will be reinjected into the subsurface soil away from the contaminated aquifer. Low-temperature thermal desorption will permanently remove contaminants from the excavated shallow soils so that these soils can be returned to SD15.

Alternative G4/S4 was selected because it best provides the following specific benefits at SD15:

- Contaminated shallow soils will be removed and treated so risk to human health will be eliminated.
- Remediation of shallow soils will be completed in about 3 months; therefore, contaminants will not be able to migrate further or act as a continuing source for contamination in the perched aquifer.
- High-vacuum extraction strips contaminants from deep soils so contaminants will not migrate to groundwater in the future.
- Active treatment of the perched aquifer will prevent contaminants from migrating to the deep aquifer.
- High-vacuum extraction is the least expensive active treatment for groundwater.

- High-vacuum extraction remediates deep soils and groundwater simultaneously; thus, separate treatment for deep soils (e.g., bioventing) is not needed.

Specific components of the selected remedy are illustrated in Figure 4.5-1 and consist of the following:

**Perched Aquifer Groundwater at SD15:**

- Institutional controls on land use and water use, as specified in the Base Comprehensive Plan, will restrict access to the contaminated groundwater throughout SD15. Installation of wells in the contaminated plume for residential, industrial, or agricultural use will be prohibited by the Base Comprehensive Plan until cleanup levels have been achieved.

- Groundwater in the perched aquifer at SD15 will be treated by a high-vacuum extraction process to remove fuel related contaminants and HVOCs.

- Recoverable quantities of free product found on top of the water table at SD15 will be removed through the high-vacuum extraction process.

- Treated water will be reinjected into the subsurface beyond the boundary of the contaminated aquifer. Reinjected water will be regularly monitored to ensure it meets cleanup and risk requirements.

- Groundwater remaining above cleanup levels will continue to be monitored semi-annually and evaluated annually to determine contaminant migration and to track the progress of the high-vacuum extraction treatment, as well as to provide an early indication of unforseen environmental or human health risk. Five-year reviews will also assess the protectiveness of the remedial action, including an evaluation of any changed site conditions, as long as contamination remains above cleanup levels.

- When two consecutive groundwater monitoring events indicate contaminant concentrations are below cleanup levels, the high-vacuum extraction system will be shut-off. Semi-annual monitoring will continue for another year, and subsurface soil samples will be collected. If levels are confirmed to be below cleanup levels one year after the system was shut-off, no further remedial action will be required. If contamination is present in any of the samples, the system will be restarted, or another remedial option will be considered.

- During the final round of groundwater monitoring, samples will be collected and analyzed for all constituents that exceeded MCLs during the 1994 investigation including VOCs and arsenic. These results will be evaluated before a final decision is made that groundwater meets all cleanup requirements.

- All groundwater is expected to be cleaned up within 5 years.

**Deep Aquifer Groundwater at SD15:**

- No further action is required for the deep aquifer groundwater at SD15.

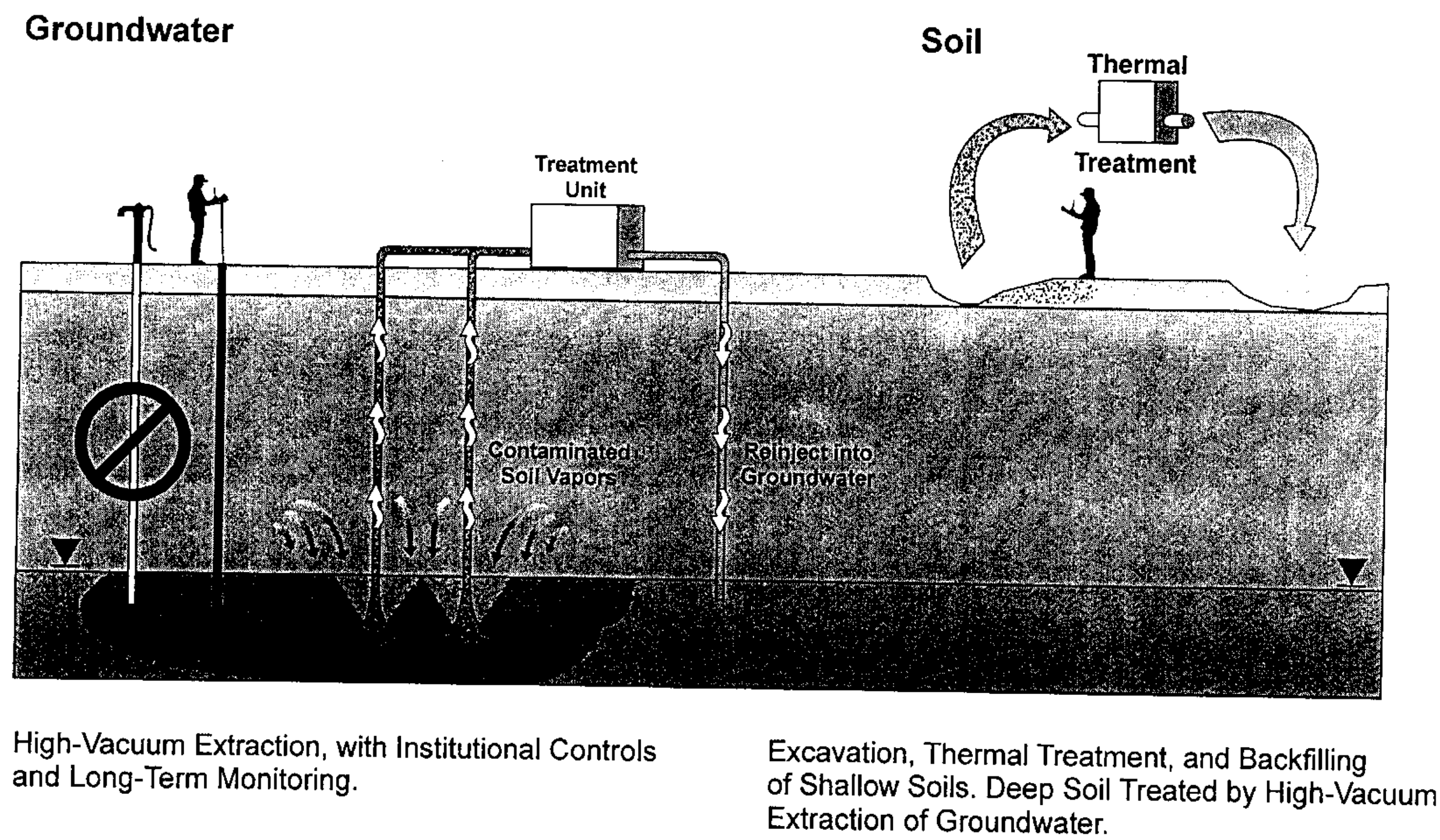


**Figure 4.5-1. Selected Alternative for SD15**

**Soil at SD15:**

- Shallow soils (less than 5 feet deep) with contamination above cleanup levels will be excavated, removed, and thermally treated to eliminate fuel-related contaminants. After treatment, no further action will be required for the shallow soils.

- Deep soils at SD15 will be actively treated through air stripping associated with the high-vacuum extraction process described for the perched aquifer groundwater.

- Soils with contamination above cleanup levels will be sampled one year after system start up and every 3 years thereafter to evaluate contaminant migration and timely reduction of contaminant concentrations by high-vacuum extraction. If cleanup levels are not being achieved, further remedial action will be evaluated. This will include 5-year reviews to assess the protectiveness of the remedial action, including an evaluation of any changed site conditions, as long as contamination remains above cleanup levels.

- When two consecutive groundwater monitoring events indicate contaminant concentrations are below cleanup levels, the high-vacuum extraction system will be shut-off. Semi-annual monitoring will continue for another year, and subsurface soil samples will be collected. If levels are confirmed to be below cleanup levels one year after the system was shut-off, no further remedial action will be required. If contamination is present in any of the samples, the system will be restarted, or another remedial option will be considered.

- All soils are expected to be cleaned up within 5 years.

A treatability study for high-vacuum extraction is currently in progress. High-vacuum extraction will be implemented until cleanup levels have been achieved. Groundwater and soil modeling predicts cleanup levels will be achieved in about 5 years. Groundwater will be monitored twice a year to evaluate the progress of the high-vacuum extraction system. Deep soils will be sampled after 1 year and every 3 years thereafter as long as contamination remains above cleanup levels. Further response actions, coordinated with the regulatory agencies, may be considered if high-vacuum extraction is determined to be ineffective.

The selected remedy for shallow soils was implemented in 1996. Approximately 170 cubic yards of fuel-contaminated soil was excavated from four contaminated areas, treated, and used to backfill the excavations. Confirmation samples indicate that two of the areas are now below cleanup levels. The other two areas still have elevated levels of contamination and will, therefore, be included in the high-vacuum extraction treatability study. Further soil excavation will only be planned if necessary after evaluation of the treatability study results.

Because the remedy will result in contaminants remaining on-site above health based levels, a review will be conducted within 5 years after commencement of remedial action. The review will ensure that the remedy continues to provide adequate protection of human health and the environment. The cleanup levels to be achieved (i.e., remediation goals) through the selected remedy for COCs at SD15 are presented in Table 4.5-1. MCLs were used as the groundwater remediation goals. One COC at SD15 (1,1,2,2-tetrachloroethane) does not have an MCL and, therefore, does not have a remediation goal. Cleanup of 1,1,2,2-tetrachloroethane will be complete when all other HVOCs have met MCLs.

The selected remedy includes provisions for the preparation of a workplan for continued environmental monitoring of the affected media. This workplan will include specific details regarding the number and location of monitoring points, as well as guidelines for eliminating select monitoring points as cleanup occurs. Environmental monitoring will be discontinued at SD15 when the remediation goals have been satisfactorily achieved (Table 4.5-1). This determination will be made jointly by the USAF, the USEPA, and the State of Alaska pursuant to the Federal Facility Agreement.

**Table 4.5-1**

**Identification of Chemical-Specific ARARs and Remediation Goals, SD15
Elmendorf AFB, AK**

| Location | Chemical | Maximum Concentration | Remediation Goal | Basis for Remediation Goal[1,2] |
|---|---|---|---|---|
| **Groundwater (Perched Aquifer):** | | | | |
| SD15 | Benzene | 1430 μg/L | 5 μg/L | MCL |
| | Ethylbenzene | 713 μg/L | 700 μg/L | MCL |
| | Toluene | 3640 μg/L | 1000 μg/L | MCL |
| | 1,1,2-Trichloroethane | 6.97 μg/L | 5 μg/L | MCL |
| | 1,2-Dichloroethane | 5.92 μg/L | 5 μg/L | MCL |
| | Trichloroethene | 143 μg/L | 5 μg/L | MCL |
| **Shallow Soils (0-5 feet bgs):** | | | | |
| SD15 | GRO | 33,000 mg/kg | 1000 mg/kg | ACM, Level D |
| | DRO | 10,000 mg/kg | 2000 mg/kg | ACM, Level D |
| | BTEX | 168 mg/kg | 100 mg/kg | ACM, Level D |
| **Deep Soils (>5 feet bgs):** | | | | |
| SD15 | GRO | 5200 mg/kg | 1000 mg/kg | ACM, Level D |
| | DRO | 6000 mg/kg | 2000 mg/kg | ACM, Level D |

[1] Maximum Contaminant Level (MCL); 40 CFR § 141.61 for Federal MCLs, and 18 AAC 80.070 for State MCLs. Federal and State MCLs are identical for the COCs.
[2] Alaska Cleanup Matrix (ACM); 18 AAC 78.315.

### 4.5.1 Statutory Determinations

The selected remedy satisfies the requirements under Section 121 of CERCLA to:

- Protect human health and the environment;
- Comply with ARARs;
- Be cost effective; and

- Utilize permanent solutions and alternative treatment technologies to the maximum extent practicable.

**Protective of Human Health and the Environment**

The selected remedy is protective of human health and the environment. The current points of exposure are limited to surface soil. Excavation of contaminated surface soil will eliminated this risk. Institutional controls will protect against the potential risk by assuring that the contaminated soils will not come in contact with people until RAOs have been met.

Risks were calculated using assumptions regarding exposure pathways and the time receptors were exposed to the contaminants. Each exposure was estimated conservatively in a manner which tends to overestimate the actual risk. Risk management decisions were made considering the uncertainty in the assumptions used in the risk assessment. At SD15, the shallow groundwater is not used and is not expected to be used in the future, so existing risks and potential risks are significantly less than the worst-case risk.

There are no direct current receptors for groundwater at SD15, but the perched contaminated groundwater could migrate to the deeper aquifer. The perched aquifer and deep soil contamination will be remediated with high-vacuum extraction under this selected remedy. Institutional controls will protect against the potential risk to human health by ensuring that contaminated perched aquifer groundwater will not be consumed by people until cleanup levels (MCLs) are met. The time required to achieve MCLs is not known, but could be as short as 5 years based on groundwater modeling results.

**Applicable or Relevant and Appropriate Requirements (ARARs)**

**Chemical-Specific ARARs** -- Chemical-specific cleanup levels (i.e., remediation goals) for SD15 are identified in Table 4.5-1. The Maximum Contaminant Levels (MCLs) established for drinking water under State and Federal laws are relevant and appropriate to groundwater contaminants of concern at SD15 as a chemical-specific regulation. Semi-annual groundwater monitoring at SD15 will document compliance with MCLs. High-vacuum extraction at SD15 will reduce groundwater contamination.

For petroleum contaminated soil that will be remediated, specific cleanup levels indentified as "Level D" in the Alaska Cleanup Matrix (ACM), 18 AAC 78.315, are relevant and appropriate (Table 4.5-1). The general ACM guidelines (18 AAC 78.315) and the ACM scoring matrix are not relevant and appropriate for SD15. Excavation and high-vacuum extraction at SD15 will reduce soil contamination. Confirmation sampling after 1 year and every 3 years thereafter until high-vacuum extraction is complete will document that cleanup goals have been achieved.

**Location-Specific ARARs** -- There are no specific ARARs which must be met because of the location of the contamination and remedial actions at SD15.

**Action-Specific ARARs** -- Installation of the reinjection well will be completed in accordance with the underground injection control program standards (AS 31 and 20 AAC 25). Additionally, the off-site disposal rule (40 CFR § 300.440) is relevant and appropriate to the selected remedy. Any hazardous substance, pollutant, or contaminant identified during the implementation of the selected remedy will be disposed of in accordance with this regulation. Action-specific ARARs for SD15 are identified in Table 4.5-2.

**Table 4.5-2**

**Identification of Action-Specific ARARs, SD15**
**Elmendorf AFB, AK**

| Standard, Requirement, Criteria, or Limitation | Citation | Description | Documentation |
|---|---|---|---|
| National Oil and Hazardous Substances Pollution Contingency Plan--Off-Site Disposal Rule | 40 CFR § 300.440 | Establishes procedures for planning and implementing off-site transfer of any hazardous substance, pollutant, or contaminant. | Relevant and appropriate if hazardous substances, pollutants or contaminants are transferred off site during implementation of the selected remedy. |
| **State of Alaska** | | | |
| Underground Injection Control Program Standards | AS 31; and 20 AAC 25 | Establishes regulations for drilling. | Substantive requirements are relevant and appropriate to SD15 because of the proposed reinjection of treated groundwater. |

AAC - Alaska Administrative Code
AS - Alaska Statute
CFR - Code of Federal Regulations

**Cost Effectiveness**

The selected remedy is the most cost effective of the alternatives because it affords overall effectiveness proportional to its costs. Alternative S4 (excavating, thermal treatment, and backfilling) was chosen for the shallow soils to prevent migration of contaminants to groundwater. Alternative S4 costs slightly more than Alternative S3, but Alternative S4 will not require yearly maintenance. Alternative G4 is about three times more expensive than Alternative G2; however, it will also remediate the groundwater in about one-third of the time as Alternative G2. Additionally, Alternative G4 will remediate the contaminated deep soils.

**Utilization of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable**

The USAF and the USEPA, with concurrence from the State of Alaska, have determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be used in a cost-effective manner at SD15. Of those alternatives that are protective of human health and the environment and comply with ARARs, the USAF and the USEPA have determined that the selected remedy provides the best balance of tradeoffs in terms of long-term effectiveness and permanence; reduction in toxicity, mobility, or volume achieved through treatment; short-term effectiveness; implementability; cost (as discussed in the preceding section); the statutory preference for treatment as a principal element; and considering State and community acceptance. The selected remedy will permanently remove the contaminants from the affected media so that the media can be returned to the site (i.e., extracted groundwater will be reinjected and excavated soils will be backfilled). The State of Alaska concurs with these determinations.

**Preference for Treatment as a Principal Element**

The selected remedy satisfies this statutory preference by using high-vacuum extraction to treat contaminated groundwater and deep soils. Additionally thermal treatment will be used to reduce contamination in shallow soils.

### 4.5.2 Documentation of Significant Changes

The Proposed Plan listed soil and groundwater contaminants with concentrations in excess of cleanup guidelines. For groundwater, this list was slightly different from the list of COCs presented in this ROD. 1,1,2,2-Tetrachloroethane was included in the groundwater COCs since, while not exceeding a cleanup goal, it did contribute to significant risk. This change did not affect the choice of alternatives at SD15. Therefore, the selected remedy for groundwater was the preferred alternative presented in the Proposed Plan (Table 7 of the Proposed Plan).

During the preparation of the OU 6 ROD, the ACM guidelines were reexamined and consensus was reached between the USEPA, the USAF, and the State of Alaska that ACM Level D was appropriate at SD15. This change did not affect the identification of COCs, nor did it affect the choice of alternatives. Therefore, the selected remedy for soils was the preferred alternative presented in the Proposed Plan (Table 7 of the Proposed Plan). All changes were a logical outgrowth of the Proposed Plan.

SECTION FIVE

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# Section 5.0
# SOURCE LF02

The following subsections describe the physical description, land use, groundwater use, and hydrogeology of LF02. The identification of activities which led to the current contamination at LF02 is also included. The discussion of the regulatory and enforcement history of LF02, the role of the response action at LF02, and community participation in the response action are included the general OU 6 discussion in Section 1.0.

## 5.1 Site Description

Source LF02 is a landfill located in the vicinity of the Boniface Gate and the Federal Aviation Administration (FAA) Air Traffic Control Center in the southeastern corner of Elmendorf AFB (see Figure 1.1-2). This source area is partially located on a bluff which separates the main floodplain of Ship Creek from an upper stream terrace. The bluff itself is associated with a change in elevation of approximately 30 to 40 feet, with the upper terrace being at an elevation of approximately 190 feet above mean sea level. The southern portion of the landfill is located on the upper terrace, while the northern portion of the site extends beyond the base of the bluff into the lower floodplain terrace. A general site map of LF02 is presented as Figure 5.1-1.

This source area was reportedly used to dispose of hard fill, construction rubble, scrap metal, and general refuse between 1940 and 1942. It appears that the landfill was originally a natural bluff face that was cleared away for debris disposal. Debris was dumped off of the bluff, and eventually bulldozers and other equipment pushed debris out to the locations now found at the site. Based on aerial photographs, landfill activities appeared to have ceased prior to 1950. The physical shape of the landfill reflects the location of the debris. The majority of the landfill is probably 10 to 20 feet thick. No final cover was applied to the waste.

The landfill has been overgrown with trees and vegetation since the mid-1950s. On a site visit conducted by the USAF and the USEPA in October 1993, it was noted that the area is currently densely vegetated, and that substantial surficial accumulations of miscellaneous metallic debris (including empty drums) are present.

### 5.1.1 Land Use

LF02 is currently designated as a "restricted use area" in the Base Comprehensive Plan. This designation provides for recreational use of the parcel (cross country skiing, etc.) and for construction of unmanned facilities such as a parking lot, storage building, or taxiway, but prohibits the construction of any sort of manned facility such as an office building or a residence. Drilling into the shallow aquifer is also restricted by the Base Comprehensive Plan. As a former landfill, LF02 will maintain this designation indefinitely.

There are no known historic buildings, archeological sites, wetlands, floodplains, or rare or endangered species at LF02. The area between LF02 and Ship Creek is a floodplain.

### 5.1.2 Hydrogeology and Groundwater Use

The discussions of the geologic and hydrogeologic settings for Sources LF02, LF03, and SD73 have been combined because of their similar hydrogeologic regimes and close proximity on the glacial outwash plain. The general site map for LF02 is presented as Figure 5.1-1. Site maps for LF03

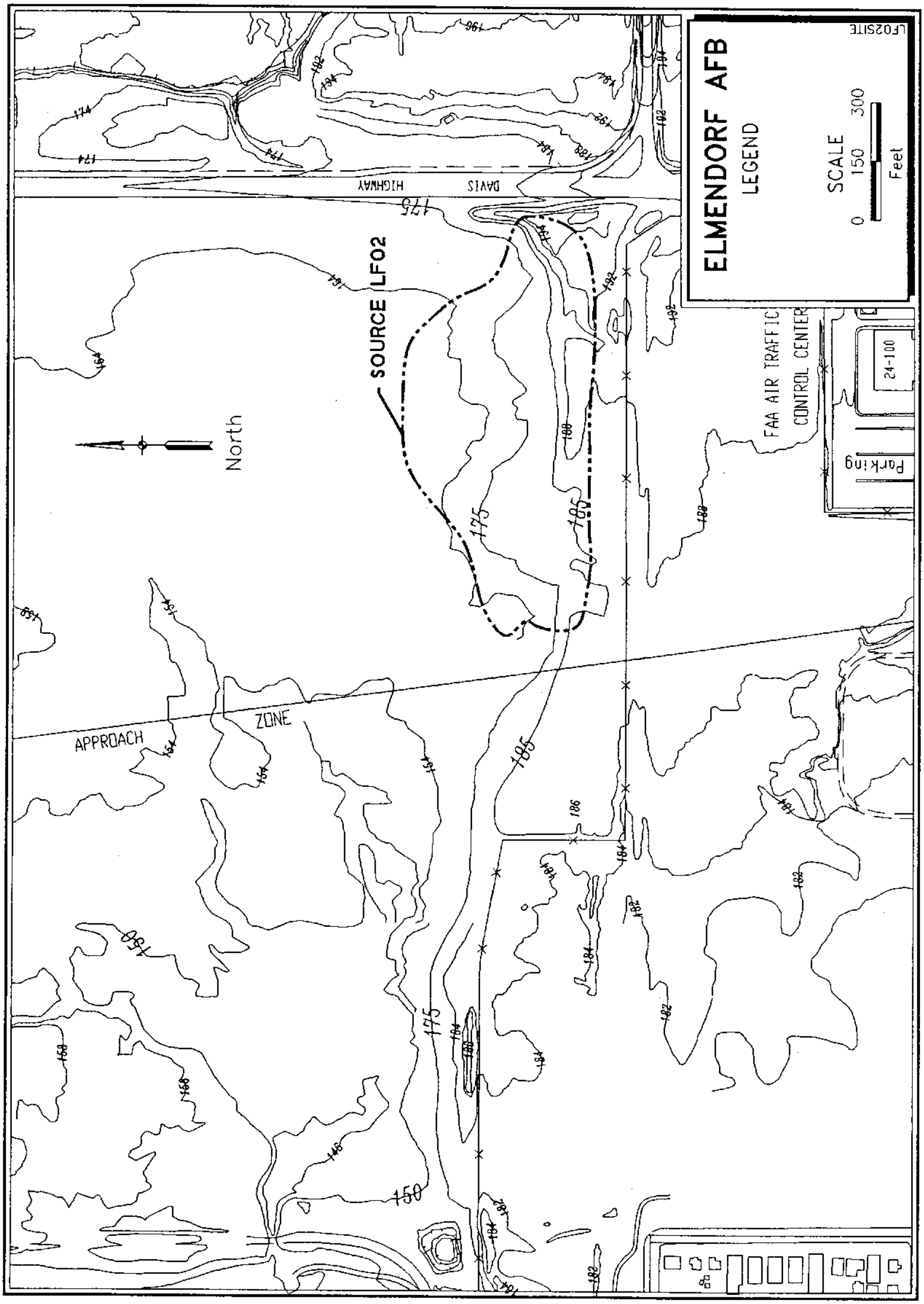


**Figure 5.1-1. Location Map for Source Area LF02**


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and SD73 are presented as Figures 6.1-1 and 7.1-1, respectively. For a more general description of Elmendorf AFB geology and hydrogeology see Section 1.0 of this document, or the OU 6 RI/FS (USAF, 1996b).

Sources LF02, LF03, and SD73 are all situated on late Quaternary glacial outwash deposits. Based on regional information, this outwash is believed to overlie silt and clay units of the Bootlegger Cove Formation, which act as an aquitard between the shallow, unconfined, aquifer and a deep confined aquifer. The Bootlegger Cove Formation was not encountered at these source areas during the OU 6 RI.

The subsurface geology at LF02 consists of well-graded sandy and silty gravels overlain by near surface silt and peat deposits. The sandy and silty gravels are the matrix for the shallow aquifer underlying the site. At LF03, similar near surface silts overlie gravels and sands. The sand and gravel unit in which the shallow aquifer is present appears to be fairly continuous in the vicinity of this source area. The subsurface geology underlying SD73 consists chiefly of gravelly sands, with interbedded silty sand units, overlain with a thin surface layer of silty clay. The shallow aquifer at SD73 resides in the coarser-grained fraction of these lithologies; however, the aquifer beneath SD73 is of generally lower yield than at LF02 or LF03. The shallow aquifer at all three outwash plain source areas is believed to overlie the Bootlegger Cove Clay.

A potentiometric surface map for the outwash plain south of Ship Creek is presented as Figure 5.1-2. Groundwater flow across the LF02 area is west-northwest, and discharges into a large marsh located 300 feet west of the landfill. From the marsh, water flows at and below ground surface, discharging into a channel which empties into Ship Creek. Groundwater flows northwest across the LF03 landfill, then bends gently to the west. Localized steepening of the water level contours can be observed just to the north of Source LF03. These are likely associated with a finer-grained composition of the aquifer in this area. At SD73, groundwater flows in a gentle arc from northwest to west. A change in groundwater flow direction toward the west and southwest is associated with the nearby presence of the bluff that partially comprises Source LF02.

The hydraulic gradient in the glacial outwash plain to the south of Ship Creek averages approximately 53 feet per mile. The gradient at the different OU 6 source areas differs from east to west. In the vicinity of Source LF03, the groundwater gradient is approximately 80 feet per mile. At SD73 and LF02, the gradient flattens to approximately 42 feet per mile. Based upon slug test data from wells over the entire area, the hydraulic conductivities in the shallow aquifer were relatively high, and ranged from 2.16E-2 to 8.37E-3 cm/sec. These findings are typical of glacial outwash deposits. A generalized hydrogeologic conceptual model for LF02 and SD73 is presented as Figure 5.1-3. The hydrogeologic conceptual model for LF03, prepared separately, is presented in Section 6.1 as Figure 6.1-2.

The groundwater in the shallow aquifer at these sites is not used for any purpose on base. Its future use, even if the aquifer was uncontaminated, is generally limited because of the higher yield of the deeper confined aquifer below the Bootlegger Cove Clay. Particularly at SD73, the fine-grained nature of the aquifer material would make the shallow aquifer unsuitable as a drinking water supply aquifer.

## 5.2 Site History and Enforcement Activities

The following section identifies the activities which lead to the current contamination at LF02. The regulatory and enforcement history for LF02 is included in the general discussion presented

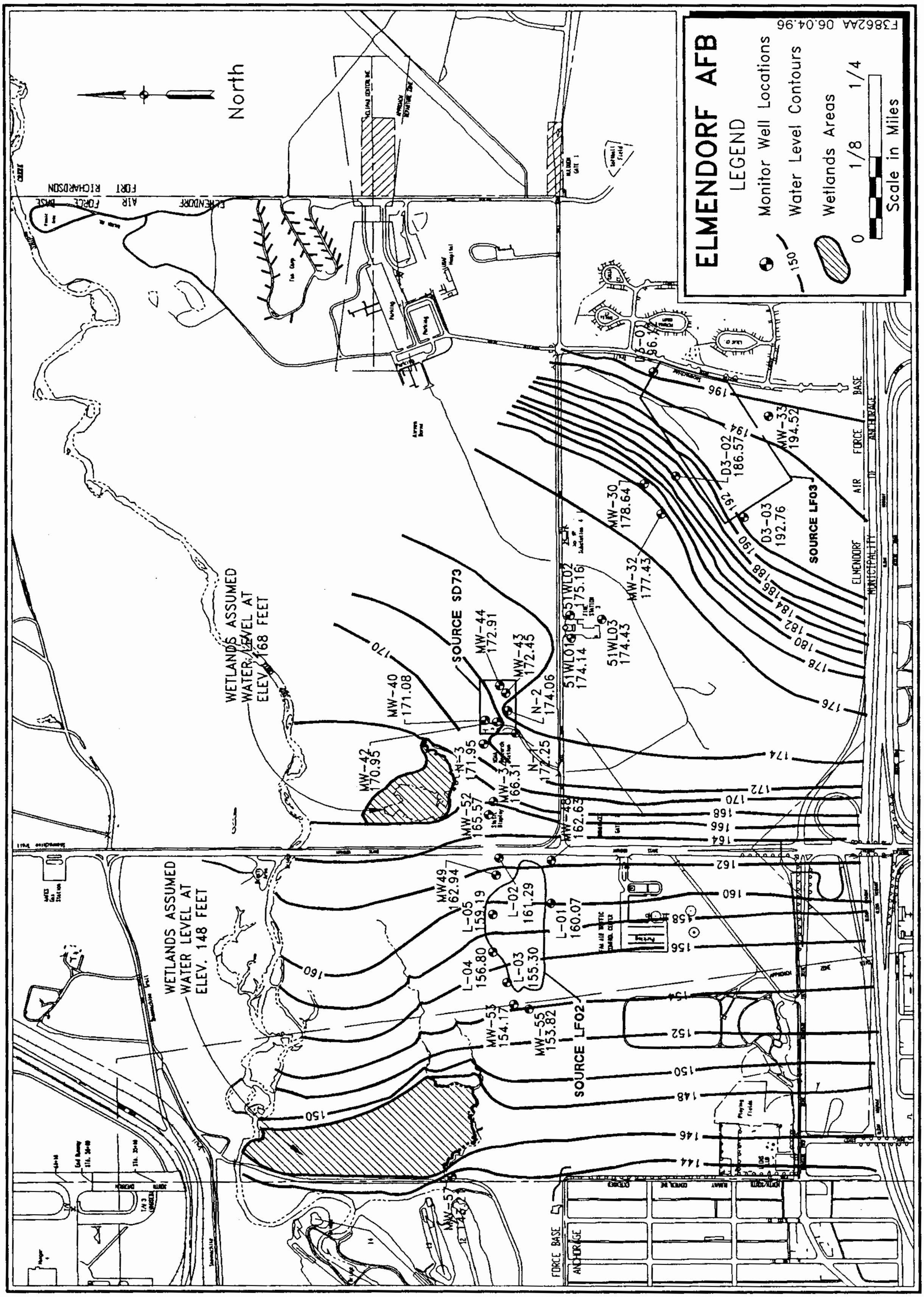


Figure 5.1-2. Potentiometric Surface of the Glacial Outwash Plain

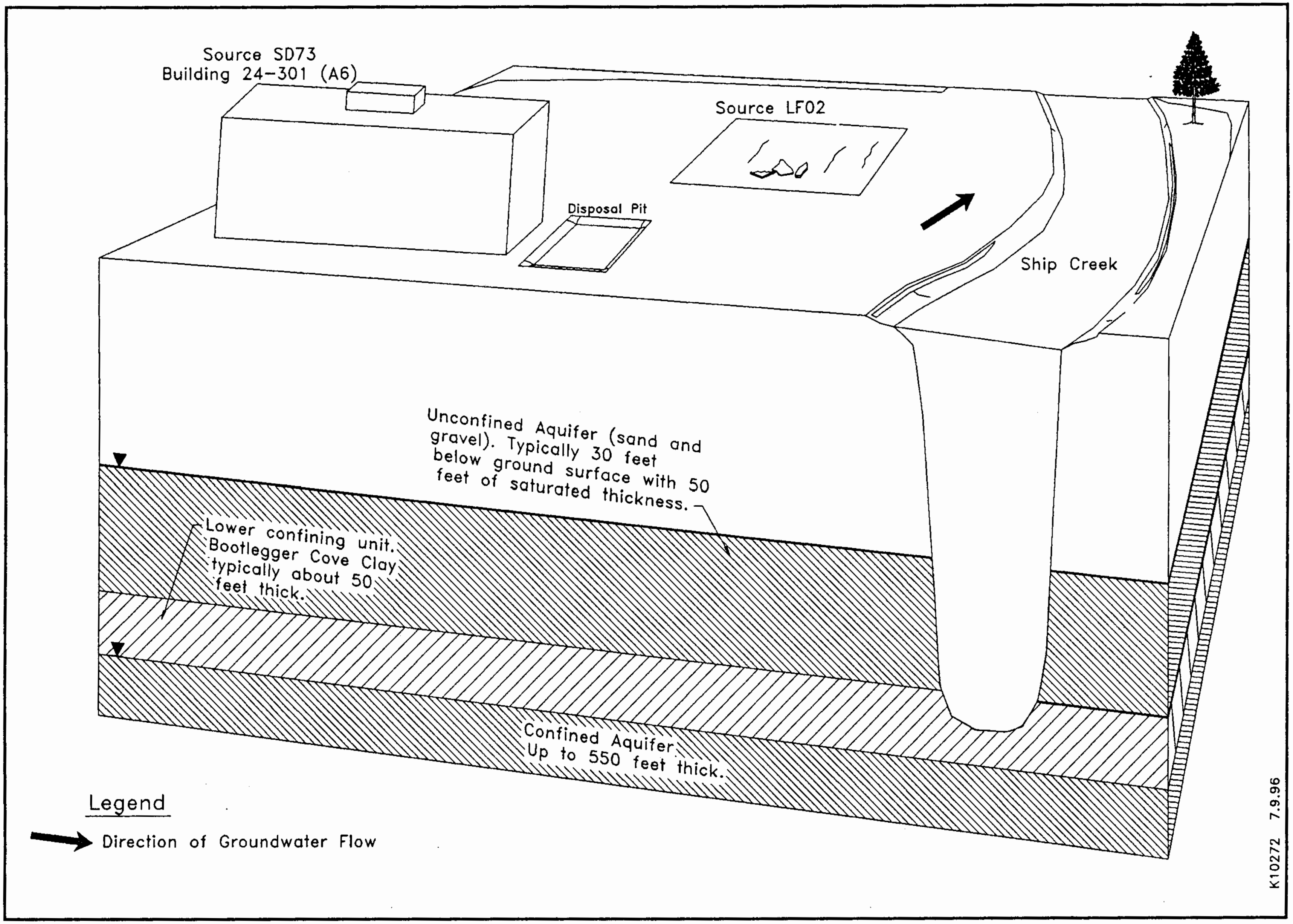


**Figure 5.1-3. Conceptual Hydrogeologic Model for LF02 and SD73**

for OU 6 in Section 1.0, as are the discussions of the role of the response action and the community participation in the response.

### 5.2.1 Identification of Activities Leading to the Current Contamination at LF02

The principal contaminants identified in the soil and groundwater at LF02 include metals, solvents, fuel-related compounds, and semi-volatile organic compounds. The sources of contamination at LF02 relate almost exclusively to waste management practices. Fueling and maintenance practices at a former gun battery facility located upgradient of the site, as well as the landfilling of various metallic and organic material at LF02, have resulted in contaminant species being made available for leaching into the soil and groundwater.

Soil contamination at LF02 represents a continuing source for future groundwater contamination via downward percolation of groundwater through the vadose zone. Seasonal fluctuations in the water table have resulted in a smear zone being detected at the base of the vadose zone within LF02. A schematic of the migration pathway of fuels, metals, and solvents through the soil and into the groundwater for Sources LF02 and SD73 is presented in Figure 5.2-1. The schematic of the migration pathway of contaminants through the soil and into the groundwater for LF03, prepared separately, is presented in Section 6.2 as Figure 6.2-1.

Prior to the RI conducted at LF02 in 1994, LF02 had been addressed under the following studies:

- IRP Phase I/II Records Search and Statement of Work (Engineering-Science, 1983);
- RCRA Facility Assessment Report (ADEC, 1988); and
- SERA Phase 1B Site Assessment (ENSR, 1993).

Landfilling practices at LF02 ceased between 1942 and the early 1950s. The gun battery located upgradient of the site was inactivated and removed around the same time landfilling at LF02 was terminated. Abandoned drums and other vessels in the vicinity of LF02 which could also act as potential contaminant sources were removed and properly disposed of in 1996.

## 5.3 <u>Site Contamination, Risks, and Areas Requiring Response Actions</u>

This section identifies the areas which were investigated, and those that require remedial action. These areas were chosen based on the risk that contaminants pose to human health and the environment. The basis of this analysis is the data collected during the RI which identified the nature and extent of contamination at LF02.

### 5.3.1 Nature and Extent of Contamination

During the RI, samples of soil and groundwater were collected and analyzed for organic and inorganic constituents. Significant levels of contaminants were detected in both the soil and groundwater at LF02. These contaminants include fuels and fuel constituents, solvents, metals, and SVOCs. The contamination present at LF02 is associated with contaminant transport in the vadose zone, dissolved aqueous transport, and volatilization. These transport mechanisms are pictorially represented for LF02 in Figure 5.2-1.

Tables 5.3-1 through 5.3-3 list the frequency of occurrence and maximum concentrations of all constituents which were detected during the RI in groundwater and soil. The tables

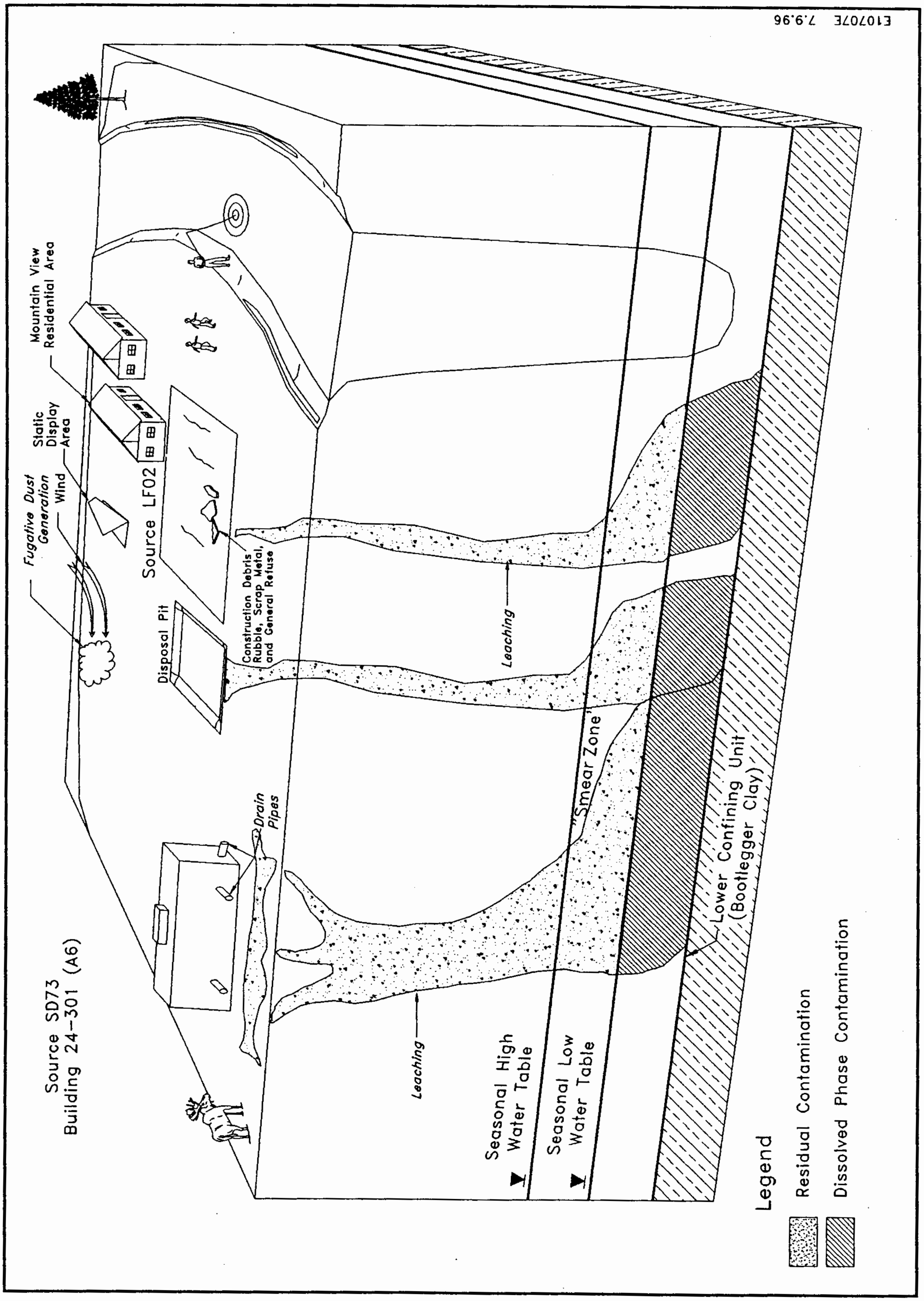


**Figure 5.2-1. Contaminant Release Mechanisms and Pathways for Exposure at LF02 and SD73**



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## Table 5.3-1

### Summary of Groundwater Analytical Results for Source LF02
### Elmendorf AFB, AK

| Method (units) | Analyte | MCL[1] | Maximum Result | Frequency of Detections Total Hits/ Total Samples | Location of Maximum Result |
|---|---|---|---|---|---|
| **Indicator Parameters** | | | | | |
| SW8015ME (µg/L) | Unidentified organics | -- | 48.1 B | 22/22 | MW-48 |
| SW8015MP (µg/L) | Unidentified organics | -- | 556 B | 20/22 | MW-48 |
| | Xylene (total) | 10000 | 1.73 | 12/22 | L01 |
| SW6010, Total (mg/L) | Aluminum | -- | 0.742 | 17/22 | MW-57 |
| | Calcium | -- | 27 | 22/22 | MW-57 |
| | Iron | -- | 1.4 | 22/22 | MW-57 |
| | Magnesium | -- | 9.7 | 22/22 | MW-57 |
| | Potassium | -- | 1.16 | 2/22 | MW-57 |
| | Sodium | -- | 4.26 | 22/22 | MW-55 |
| SW6010, Dissolved (mg/L) | Aluminum | -- | 0.0546 B | 1/1 | L02 |
| | Calcium | -- | 24.2 | 1/1 | L02 |
| | Iron | -- | 0.0253 B | 1/1 | L02 |
| | Magnesium | -- | 4.99 | 1/1 | L02 |
| | Sodium | -- | 3.56 | 1/1 | L02 |
| **Contaminant Parameters** | | | | | |
| SW8015MP (µg/L) | Gasoline | -- | 59.4 | 1/22 | L01 |
| SW8260 (µg/L) | Acetone | -- | 14.3 B | 22/22 | L01 |
| | Benzene | 5 | 0.88 | 6/22 | MW-53 |
| | Chlorobenzene | -- | 0.16 | 1/22 | L03 |
| | Chloroethane | -- | 0.012 B | 2/22 | MW-53 |
| | Chloromethane | -- | 4.36 | 21/22 | L03 |
| | Dibromomethane | -- | 0.23 B | 4/22 | MW-52 |
| | 1,2-Dichlorobenzene | 600 | 0.37 B | 1/22 | L04 |
| | 1,2-Dichloroethane | 5 | 3.52 | 12/22 [2] | MW-55 |
| | cis-1,2-Dichloroethene | 70 | 0.12 B | 4/22 | MW-49 |
| | trans-1,2-Dichloroethene | 100 | 0.16 | 1/22 | MW-52 |
| | Ethylbenzene | 700 | 0.82 | 6/22 | L01 |
| | Methylene chloride | 5 | 7.84 | 21/22 [2] | L04 |
| | 1,1,2,2-Tetrachloroethane | -- | 45.1 | 11/22 | MW-49 |
| | Toluene | 1000 | 3.58 B | 19/22 | MW-53 |
| | Trichloroethene | 5 | 5.39 | 12/22 | MW-49 |
| | m&p-Xylene | -- | 1.45 | 5/22 | L01 |
| | o-Xylene | -- | 0.38 | 6/22 | L01 |
| SW8270 (µg/L) | Dimethylphthalate | -- | 31.7 | 8/22 | L03 |
| | bis(2-Ethylhexyl)phthalate | 6 | 11.8 | 2/22 | L03 |
| | Naphthalene | -- | 1.32 | 2/22 | L03 |
| SW6010, Total (mg/L) | Barium | 2 | 0.0444 | 22/22 | MW-57 |
| | Beryllium | 0.004 | 0.00171 B | 17/22 | MW-48 |
| | Manganese | -- | 0.406 | 19/22 | MW-57 |

## Table 5.3-1

## (Continued)

| Method (units) | Analyte | MCL[1] | Maximum Result | Frequency of Detections Total Hits/ Total Samples | Location of Maximum Result |
|---|---|---|---|---|---|
| SW6010, Total (mg/L) (continued) | Zinc | -- | 0.0194 | 11/22 | L04 |
| SW7421, Total (mg/L) | Lead | 0.015 [3] | 0.00732 | 1/22 | L01 |
| SW6010, (Dissolved) (mg/L) | Barium | 2 | 0.00507 B | 1/1 | L02 |
| | Manganese | -- | 0.00911 | 1/1 | L02 |

[1] Maximum contaminant level (MCL); 40 CFR § 141.61 for Federal MCLs, and 18 AAC 80.070 for State MCLs. Federal and State MCLs are identical for the listed constituents.

[2] Frequency "hits" calculation does not include one or more results removed from the data set because they did not meet QA/QC criteria. Total sample count includes all samples analyzed for the indicated parameter.

[3] From 40 CFR, Section 141.11 for inorganics and Section 141.12 for organics (effective 1 July 1991); however, the lead level is effective only until 7 December 1992. There is no longer an MCL for lead or copper (56 Federal Register 26460, June 7, 1991); however, there is an action level of 0.015 mg/L for lead and 1.3 mg/L for copper.

B - Sample concentration was less than or equal to the blank UTL.

## Table 5.3-2

## Summary of Surface Soil Analytical Results for Source LF02
## Elmendorf AFB, AK

| Method (units) | Analyte | ACM Guideline [1] | Background Upper Tolerance Limit | Maximum Result | Depth of Maximum Results (ft) | Frequency of Detection Total Hits/ Total Samples | Location of Maximum Result |
|---|---|---|---|---|---|---|---|
| **Indicator Parameters** | | | | | | | |
| SW9045 (pH units) | pH | -- | -- | 8.02 | 1 | 3/3 | SS-097 |
| D2216 (percent) | Percent moisture | -- | -- | 28.6 | 3 | 34/34 | SS-106 |
| SW8015ME (mg/kg) | Unidentified organics [UDRO] | 1000 | -- | 681 | 2.5 | 21/22 | SS-108 |
| SW8015MP (mg/kg) | Unidentified organics [UGRO] | 500 | -- | 90.3 | 2 | 6/22 | MW-52 |
| SW6010 (mg/kg) | Aluminum | -- | 31183.96 | 21700 | 2 | 22/22 | SS-091 |
| | Calcium | -- | 8013.23 | 40700 | 2.5 | 22/22 | SS-108 |
| | Iron | -- | 43192.35 | 196000 | 2 | 22/22 | SS-109 |
| | Magnesium | -- | 10904.10 | 10600 | 3 | 22/22 | SS-099 |
| | Potassium | -- | 845.75 | 1790 | 3 | 22/22 | SS-106 |
| | Sodium | -- | 427.05 | 1460 | 2.5 | 21/22 [2] | SS-095 |
| **Contaminant Parameters** | | | | | | | |
| SW8015ME (mg/kg) | Diesel | 1000 | -- | 1550 | 2 | 1/22 | MW-52 |
| SW8015MP (µg/kg) | Benzene | 500 [3] | -- | 10.4 B | 2 | 2/22 | SS-109 |
| | Toluene | -- [3] | -- | 13.1 B | 2.5 | 9/22 | SS-095 |
| | Xylene (total) | -- [3] | -- | 32.3 | 2.5 | 6/22 | SS-095 |
| SW8240 (µg/kg) | Acetone | -- | -- | 66.5 BX | 2.5 | 12/22 | SS-095 |
| | 2-Butanone(MEK) | -- | -- | 17.2 B | 1 | 2/22 | SS-097 |
| | Chloroform | -- | -- | 38.3 | 3 | 15/22 | SS-106 |
| | 1,1-Dichloroethene | -- | -- | 2.9 X | 2.5 | 1/22 | SS-108 |
| | Methylene chloride | -- | -- | 5.71 B | 2 | 7/22 | SS-109 |
| SW8270 (mg/kg) | Benzo(b)fluoranthene | -- | -- | 0.0627 F | 3 | 1/22 | SS-098 |
| | Benzo(k)fluoranthene | -- | -- | 0.0627 F | 3 | 1/22 | SS-098 |
| | Chrysene | -- | -- | 0.0513 | 3 | 2/22 | SS-098 |
| | 1,2-Dichlorobenzene | -- | -- | 0.045 | 3 | 1/22 | SS-106 |
| | 1,4-Dichlorobenzene | -- | -- | 0.0377 | 3 | 1/22 | SS-106 |
| | Fluoranthene | -- | -- | 0.118 | 3 | 1/22 | SS-098 |
| | 2-Methylnaphthalene | -- | -- | 0.209 | 3 | 6/22 | SS-104 |
| | Naphthalene | -- | -- | 0.477 | 2.5 | 5/22 | SS-111 |
| | Phenanthrene | -- | -- | 0.214 | 2.5 | 5/22 | SS-111 |
| | Pyrene | -- | -- | 0.0795 | 3 | 1/22 | SS-098 |
| SW6010 (mg/kg) | Antimony | -- | NA | 122 | 2.5 | 13/25 | SS-108 |
| | Barium | -- | 196.45 | 2160 | 2.5 | 22/22 | SS-108 |
| | Beryllium | -- | 0.76 | 0.615 | 2 | 20/22 | SS-110 |
| | Cadmium | -- | 2.68 | 20.4 | 2.5 | 4/22 | SS-108 |
| | Chromium | -- | 48.44 | 74.8 | 2.5 | 22/22 | SS-108 |
| | Cobalt | -- | 19.52 | 14.3 | 2 | 22/22 | SS-109 |
| | Copper | -- | 31.67 | 1170 | 2 | 22/22 | SS-109 |



062823

## Table 5.3-2

## (Continued)

| Method (units) | Analyte | ACM Guideline [1] | Background Upper Tolerance Limit | Maximum Result | Depth of Maximum Results (ft) | Frequency of Detection Total Hits/ Total Samples | Location of Maximum Result |
|---|---|---|---|---|---|---|---|
| SW6010 (mg/kg) (continued) | Manganese | -- | 929.98 | 1010 | 2 | 22/22 | SS-110 |
| | Molybdenum | -- | NA | 18.5 | 2 | 20/22 | SS-109 |
| | Nickel | -- | 50.68 | 46.6 | 2.5 | 22/22 | SS-108 |
| | Selenium | -- | 0.54 | 17.1 | 2.5 | 12/22 | SS-111 |
| | Silver | -- | 1.68 | 6.98 | 1 | 6/22 | SS-097 |
| | Thallium | -- | NA | 12 | 2 | 1/22 | SS-109 |
| | Vanadium | -- | 101.64 | 118 | 3 | 22/22 | SS-106 |
| | Zinc | -- | 90.01 | 1360 | 2.5 | 22/22 | SS-108 |
| SW7060 (mg/kg) | Arsenic | -- | 13.27 | 28.6 | 2.5 | 22/22 | SS-108 |
| SW7421 (mg/kg) | Lead | -- | 10.69 | 6080 | 2.5 | 34/34 | SS-108 |

[1] Alaska Cleanup Matrix (ACM) Level C; 18 AAC 78.315.
[2] Frequency "hits" calculation does not include one or more results removed from the data set because they did not meet QA/QC criteria. Total sample count includes all samples analyzed for the indicated parameter.
[3] The ACM Level C guideline for benzene, toluene, ethylbenzene, and xylenes (BTEX) combined is 50,000$\mu$g/kg.

B - Sample concentration was less than or equal to the blank UTL.
F - Co-elution or interference was suspected.
NA - Not applicable.
X - The recoveries of one or more of the internal standards were outside the applicable acceptance criteria. The X-flag indicates which compounds were quantitated using the affected internal standard(s).

## Table 5.3-3

## Summary of Subsurface Soil Analytical Results for Source LF02
## Elmendorf AFB, AK

| Method (units) | Analyte | ACM Guideline [1] | Background Upper Tolerance Limit | Maximum Result | Depth of Maximum Results (ft) | Frequency of Detection Total Hits/ Total Samples | Location of Maximum Result |
|---|---|---|---|---|---|---|---|
| **Indicator Parameters** | | | | | | | |
| SW9045 (pH units) | pH | -- | -- | 7.01 | 20.5 | 1/1 | MW-48 |
| D2216 (percent) | Percent moisture | -- | -- | 16.2 | 5 | 16/16 | SS-125 |
| SW8015ME (mg/kg) | Unidentified organics [UDRO] | 1000 | -- | 1480 | 18 | 4/4 | MW-52 |
| SW8015MP (mg/kg) | Unidentified organics [UGRO] | 500 | -- | 2850 | 12 | 2/4 | MW-52 |
| SW6010 (mg/kg) | Aluminum | -- | 18116.77 | 16600 | 28 | 4/4 | MW-52 |
| | Calcium | -- | 10264.39 | 9040 | 28 | 4/4 | MW-52 |
| | Iron | -- | 38483.64 | 28500 | 28 | 4/4 | MW-52 |
| | Magnesium | -- | 14784.34 | 9850 | 28 | 4/4 | MW-52 |
| | Potassium | -- | 1114.35 | 907 | 22 | 4/4 | MW-52 |
| | Sodium | -- | 365.59 | 164 | 28 | 4/4 | MW-52 |
| **Contaminant Parameters** | | | | | | | |
| SW8015MP (μg/kg) | Ethylbenzene | -- [2] | -- | 37.9 | 36 | 1/4 | MW-48 |
| | Toluene | -- [2] | -- | 163 | 12 | 1/4 | MW-52 |
| | Xylene (total) | -- [2] | -- | 155 P | 12 | 2/4 | MW-52 |
| SW8240 (μg/kg) | Acetone | -- | -- | 46.9 B | 12 | 3/4 | MW-52 |
| SW6010 (mg/kg) | Antimony | -- | NA | 184 | 5 | 3/7 | SS-125 |
| | Barium | -- | 95.93 | 74.9 | 36 | 4/4 | MW-48 |
| | Beryllium | -- | 0.64 | 0.508 | 28 | 4/4 | MW-52 |
| | Cadmium | -- | 3.07 | 0.686 | 18 | 1/4 | MW-52 |
| | Chromium | -- | 76.94 | 29.9 | 28 | 4/4 | MW-52 |
| | Cobalt | -- | 17.62 | 9.59 | 28 | 4/4 | MW-52 |
| | Copper | -- | 59.84 | 54 | 28 | 4/4 | MW-52 |
| | Manganese | -- | 709.45 | 603 | 28 | 4/4 | MW-52 |
| | Molybdenum | -- | NA | 1.44 | 22 | 4/4 | MW-52 |
| | Nickel | -- | 71.79 | 32.1 | 28 | 4/4 | MW-52 |
| | Selenium | -- | 0.48 | 5.16 B | 18 | 1/4 | MW-52 |
| | Silver | -- | 1.06 | 0.334 B | 18 | 1/4 | MW-52 |
| | Vanadium | -- | 66.16 | 60.4 | 28 | 4/4 | MW-52 |
| | Zinc | -- | 76.17 | 65.8 | 28 | 4/4 | MW-52 |
| SW7060 (mg/kg) | Arsenic | -- | 9.31 | 7.63 | 22 | 4/4 | MW-52 |
| SW7421 (mg/kg) | Lead | -- | 10.13 | 6170 | 5 | 13/13 | SS-118 |

[1] Alaska Cleanup Matrix (ACM) Level C; 18 AAC 78.315.
[2] The ACM Level C guideline for benzene, toluene, ethylbenzene, and xylenes (BTEX) combined is 50,000μg/kg.
B - Sample concentration was less than or equal to the blank UTL.
NA - Not Applicable.
P - Analyte quantitation not confirmed. Results from primary and secondary GC columns differ by greater than a factor of three.

do not include results below the detection limit. The MCLs for groundwater and the ACM guidelines for soil are also listed on the tables for all constituents. Results are separated between "indicator parameters" and "contaminant parameters." Indicator parameters primarily include metals classified as nutrients, and non-speciated fuel constituents such as unidentified diesel range organics (UDRO) which are unsuitable for use in a risk assessment. A detailed discussion of the determination of the COC for LF02 is presented in Section 5.3.3.

**Groundwater Contamination at LF02**

Groundwater contaminants at LF02 include primarily low levels of fuel constituents, metals, solvents, and other volatile organic compounds (Table 5.3-1). Fuel constituents, such as gasoline and unidentified organics, were detected in samples from wells at maximum concentrations of 556 $\mu$g/L and 59.4 $\mu$g/L, respectively. The maximum unidentified organic detection was detected in a sample from MW-48, but the concentration was flagged as being near the level detected in blank samples. This well is also located upgradient of the actual LF02 landfill. Numerous VOCs were detected in the groundwater, but among these, the highest single detection was for 1,1,2,2-tetrachloroethane, at 45.1 $\mu$g/L. Three SVOCs were detected at low levels, with the highest detection for each occurring in the same well (L03). In general, organic groundwater contaminant concentrations at LF02 were substantially lower than at any of the previously discussed OU 6 source areas.

Several metals were also detected in the groundwater at LF02. These include relatively low concentrations of barium, beryllium, manganese, and zinc (Table 5.3-1). As at other OU 6 source areas, a statistical comparison of these metals concentrations was made to available background metals concentration from the *Elmendorf Air Force Base, Alaska, Basewide Background Sampling Report* (USAF, 1993). Based on this evaluation, all metals evaluated in the groundwater at LF02 were determined to be at or near background concentrations. The summary statistics for the USGS data, including the upper confidence limit concentrations used for these comparisons, are presented in Table 2.3-4.

In addition to sampling groundwater at LF02, seeps were also sampled. Analytical results indicated low levels of VOCs in the seeps. No MCLs were exceeded.

**Soil Contamination at LF02**

Soil data from LF02 were evaluated based upon surface and subsurface contaminant occurrences. Surface soils include all soils collected from depths shallower than 3 feet bgs. Subsurface soils are those collected from below 3 feet. Tables 5.3-2 and 5.3-3 list the sample depths, maximum concentrations, locations, and guidelines associated with the ACM for non-UST soil for all contaminant parameters in the surface and subsurface soil samples at LF02. Results below the detection limits are not included in the analytical summary tables.

Contamination in the surface soils at LF02 consists almost exclusively of fuels or fuel constituents, and metals. BTEX constituents were detected in the surface soils (excluding ethylbenzene), with the maximum detection being for xylene at 32.3 $\mu$g/kg (Table 5.3-2). Diesel and UGRO were both detected at elevated concentrations in samples from the pilot boring for MW-52; however, this well was drilled to investigate a source upgradient of LF02. In general, nearly all of the elevated fuel and fuel constituent results seen for both surface and subsurface soils were detected in samples from this upgradient source. Numerous SVOCs were detected at low levels in the surface soils at the landfill, with the maximum detection being for fluoranthene at 0.118 mg/kg.

Metals were frequently detected in the surface soils at LF02. A comparison to background results (Table 5.3-2) indicated that most metals are at or near background concentrations. One notable exception was lead, which was detected in several samples at concentrations greater than 1000 mg/kg, with a maximum concentrations of 6080 mg/kg in the 2-2.5 ft bgs interval. As discussed in Section 5.2.1, landfilling practices are believed to be the source for the lead and other metals detected at LF02.

The contaminants present in the subsurface soil at LF02 were of generally similar types and concentrations to those of the surface. SVOCs and metals were the most pervasive contaminants (Table 5.3-3). As with the surface soils, the highest fuel constituent detections were from the source upgradient to LF02. With the exception of lead, metals detections were determined to be predominantly at or near background concentrations based upon a comparison to background concentrations. Lead was detected in the subsurface at a maximum concentration of 6170 mg/kg in the 3 to 5 feet bgs interval. The background concentrations are included in the soil analytical summary tables. The COCs for soil at LF02 are presented in Section 5.3.3.

### 5.3.2 Risk Evaluation

Based on the concentrations of contaminants detected during the RI, human health and environmental risk assessments were performed to determine if areas should be considered for remedial action. All concentrations of contaminants, including all contaminants of concern, whether exceeding MCLs, or ACM guidelines or not, were included in the risk assessments. The general discussion of the human health and ecological risk assessment procedures is presented in Section 2.3.2, and will not be repeated since the procedures for each of the source areas within OU 6 were identical. Details on the parameters used in the Health Risk Assessment are shown on Table 2.3-5.

**Human Health Risk Assessment (HRA)**

Since LF02 is not currently used residentially, a *current* residential risk scenario was not evaluated, and only current visitor and trench worker scenarios were applied. Even though the future land use at LF02 is restricted as specified in the Base Comprehensive Plan, the *future* residential risk scenario was evaluated to obtain the most conservative risk information possible.

ELCRs and HIs were calculated to describe cancer and noncancer risks, respectively. The ELCR is the additional chance that an individual exposed to site contamination will develop cancer during his/her lifetime. It is expressed as a probability such as 1.0E-06 (one in a million). The HI estimates the likelihood that exposure to the contamination will cause some negative health effect. An HI score above one indicates that some people exposed to the contamination may experience at least one negative health effect.

The calculated risks at LF02 are based upon hypothetical exposure to soil and groundwater. Seep data were combined with landfill groundwater data to determine risk. The shallow groundwater aquifer at LF02 is not presently used, and will not be used in the future for supplying potable or non-potable water. For carcinogenic soil risk, the calculated results for the future resident (RME), construction worker, and visitor are listed. Only the future resident scenario (RME) was used to calculate carcinogenic groundwater risk. Table 5.3-4 summarizes the calculated carcinogenic and noncarcinogenic human health risks calculated for LF02.

## Table 5.3-4

## Summary of Human Health Risks at LF02
## Elmendorf AFB, AK

| Risk | Surface Soil (<3 feet) | | Subsurface Soil | Chemical(s) Driving Risk |
|---|---|---|---|---|
| | Residential Scenario[a] | Visitor Scenario[b] | Trench Worker Scenario[c] | |
| **Soil Risk [d]** | | | | |
| Carcinogenic | 2.3E-05 | 1.5E-06 | <1.0E-06 | Arsenic |
| Non-Carcinogenic | 2.8 | 0.14 | NR | Arsenic, Manganese |
| **Groundwater Risk [d]** | | | | |
| Carcinogenic | 3.1E-05 | NA | NA | 1,1,2,2-Tetrachloroethane<br>1,2-Dichloroethane |
| Non-Carcinogenic | NR | NA | NA | NA |

[a] Excess cancer risks conservatively assumed for 30 years of exposure (drinking groundwater, contact with soil, etc.) by future residents (Reasonable Maximum Exposure).
[b] Excess cancer risks conservatively assumed for 30 years of exposure while visiting the site under current conditions.
[c] Excess cancer risks conservatively assumed for 1 year of exposure during on-site construction work (digging, etc.).
[d] Risks are calculated by using the 95% upper confidence limits (UCLs) for contaminants present unless the 95% UCL exceeded the maximum concentration detected, in which case the maximum concentration was used. This represents a conservative estimate of the "worst case" contamination.
NA - Not applicable.
NR - Significant risk not identified.

Cancer risk using the residential RME scenario for groundwater at LF02 exceeds 1.0E-05. The low levels of 1,1,2,2-tetrachloroethane present at the site drive this risk. No noncarcinogenic risk was identified for groundwater.

Shallow soil carcinogenic RME risk at LF02 exceeds 1.0E-05 for the RME scenario, and 1.0E-06 for the visitor scenario. Only the RME noncarcinogenic risk exceeded 1.0. No significant risk was identified under the trench worker scenario. Soil risk was 100% attributable to metals, which are believed to be at background concentrations.

Lead was detected at depth in LF02 and evaluated using USEPA's Lead Uptake/Biokinetic Model to determine whether the lead levels present posed a risk. It was initially determined that the levels present would not pose sufficient risk to require action. Subsequently, additional sampling demonstrated that lead in excess of USEPA screening levels is present nearer the surface at LF02 than was originally thought to be the case (within 2 feet of the ground surface in some places). Although the model still indicates that the lead should not pose an unacceptable risk, given the potential for children to play in the area, it appears prudent to add an additional 2 foot soil cover at areas with elevated lead concentrations to reduce potential exposure.

**Ecological Risk Assessment (ERA)**

The ERA was performed to determine if the reported concentrations of chemicals or calculated exposures to plants and wildlife at OU 6 are likely to produce adverse effects. Ecological effects were evaluated quantitatively by calculating Ecological Quotients (EQs). The ERA focused on evaluating potential impacts of the contamination on selected indicator species: the moose, masked shrew, meadow vole, black-capped chickadee, merlin, and peregrine falcon. The general discussion of the ecological risk assessment procedures is presented in Section 2.3.2 and will not be repeated since the procedures for each of the source areas within OU 6 were identical.

The EQ of 1.0 was exceeded for the meadow vole, masked shrew, and black capped chickadee in the landfill area due to elevated concentrations of lead, barium, copper, selenium and zinc. The highest EQs at the LF02 landfill are associated with zinc (up to 1320 for the black capped chickadee), which drives the ecological risk in this area. EQs were calculated based on shallow soil and seep contaminant concentrations. Most of the contribution to ecological risk is associated with metals contamination in shallow soil.

None of the calculated EQs exceeded 1.0 for the moose, peregrine falcon, or merlin at LF02. The upgradient source at LF02 was not evaluated from an ecological risk point of view because insufficient information was collected to conduct this evaluation. Furthermore, this area is located next to a busy road and is mowed and maintained by the base. Therefore, it is an unlikely habitat for wildlife.

**Uncertainties Associated with the Risk Assessment**

The major assumptions and uncertainty factors for the OU 6 human health and ecological risk assessments are presented in Section 2.3.2.

### 5.3.3 Conclusions

The following subsections provide a discussion of the determination of COCs for LF02, the location and extent of contamination by COCs in excess of preliminary remediation goals, and a summary statement about the risk to public health, welfare, or the environment if action is not taken at LF02.

**Contaminants of Concern**

Constituents exceeding preliminary remediation goals (MCLs for groundwater or seeps, ACM guidelines for soils) were identified in the Proposed Plan. COCs were developed from the results of the risk assessment and by considering preliminary remediation goals. Each constituent having an individual contribution of greater than 1.0E-06 carcinogenic (RME) risk, or an HI greater than 0.1 when the cumulative HI for the site is greater than 1.0, was considered as a COC. In addition, any constituent exceeding preliminary remediation goals (MCLs for groundwater or seeps, ACM guidelines for soil) was also considered as a COC. The final COCs for LF02 are shown on Table 5.3-5, with the individual risk contributed and basis for identifying the COC (risk or regulatory standard).

Only one COC was identified for groundwater at LF02 (Table 5.3-5). 1,1,2,2-Tetrachloroethane was retained as a COC as the principal contributor to carcinogenic risk at the site. The occurrence of this constituent is presented graphically on Figure 5.3-1. There is no MCL for 1,1,2,2-tetrachloroethane; therefore, this map is drawn based upon the exceedance of a risk-based cleanup goal of 0.43 $\mu$g/L.

Groundwater data from the former gun battery (i.e., static display area) was evaluated as an upgradient source to LF02. 1,1,2,2-Tetrachloroethane was the only groundwater risk driver from the static display area. The highest concentration of this constituent at LF02 was detected in a well at the upgradient edge of the LF02 landfill. Data indicate that the 1,1,2,2-tetrachloroethane in the LF02 area originated from this former upgradient source. Since the current contamination is adjacent to the landfill area, all 1,1,2,2-tetrachloroethane in groundwater will be addressed as part of LF02. Data also suggest that the low levels of 1,1,2,2-tetrachloroethane seen at seep location SP-06 also originated from this same source; therefore, seep SP-06 will also be addressed along with the LF02 groundwater. The estimated volume of these areas of groundwater contamination is 3.5 million gallons.

The Proposed Plan identified three groundwater constituents as exceeding MCLs: methylene chloride, trichloroethene, and bis(2-ethylhexyl)phthalate. These three constituents were not identified as COCs because they did not contribute to significant risk. Metals were also detected in the groundwater at LF02. Metals were not included as COCs because: (1) their analytical results were less than MCLs; (2) their contribution to health risk was insignificant; and (3) their concentrations were comparable to background levels.

Uncovered landfill waste at LF02, particularly debris that is exposed at the surface of the landfill, was identified as an element requiring a response action at LF02. Debris such as old cans, automotive parts, crushed drums, old piping, etc., are believed to represent a threat to human health or the environment. As a consequence, exposed landfill waste is listed as a COC for the shallow soils at LF02. The projected area requiring action is depicted in Figure 5.3-2. The estimated area requiring action is approximately 4 acres.

In addition to exposed landfill waste, concerns were expressed during the public comment period for OU 6 over lead levels in the shallow soils (0 to 2 feet bgs) at LF02. While lead was not originally retained as a COC at LF02, subsequent evaluation of additional lead data at LF02 indicated elevated lead levels were present in shallow soils requiring a response action. Because a response action is required, lead was retained as a COC. The areas requiring a response include all locations where lead concentrations exceeded 500 mg/kg in samples occurring at a depth of 2 feet or less bgs. Three small areas meet this criterion. The areas requiring a response action for lead are depicted on Figure 5.3-3. The estimated volume of lead-impacted soil is 1200 cubic yards.

## Table 5.3-5

## Summary of Contaminants of Concern[1] at LF02
## Elmendorf AFB, AK

| Chemical | Maximum Concentration | Maximum Cancer Risk | Maximum Hazard Index | Basis for COC | Remediation Goal | Basis for Remediation Goal |
|---|---|---|---|---|---|---|
| **Groundwater/Seeps:** | | | | | | |
| 1,1,2,2-Tetrachloroethane | 45.1 µg/L | 2.7E-04 | -- | Contributes to a risk > 1.0E-06 | 0.43 µg/L | Risk Based |
| **Shallow Soils (0-2 feet bgs):** | | | | | | |
| Lead | 4937 mg\kg | -- | -- | Lead Uptake/Biokinetic Model | -- | -- |
| Exposed landfill waste | -- | -- | -- | Alaska solid waste regulations | -- | -- |
| **Deep Soils (>2 feet bgs):** (No COCs for Deep Soils) | | | | | | |

[1]Cancer risk ≥ 1.0E-06 or HI ≥ 0.1 for soil or groundwater scenario with a total HI of ≥ 1.0; or concentrations found in excess of regulatory levels. If cancer risk or HI did not exceed standards, it was marked as "--".

bgs - Below ground surface

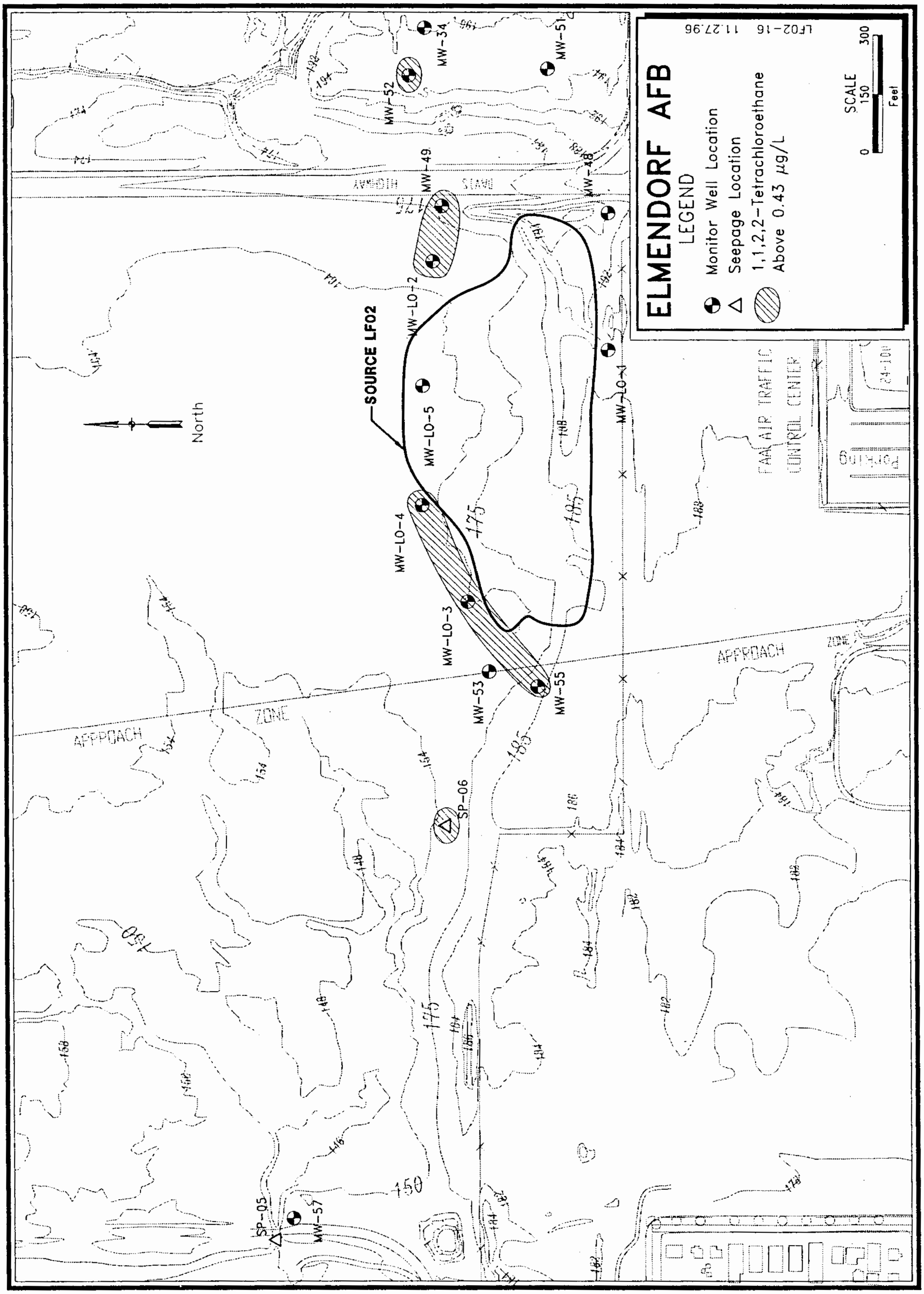


**Figure 5.3-1. Chlorinated Solvent Plume in the Groundwater at LF02**

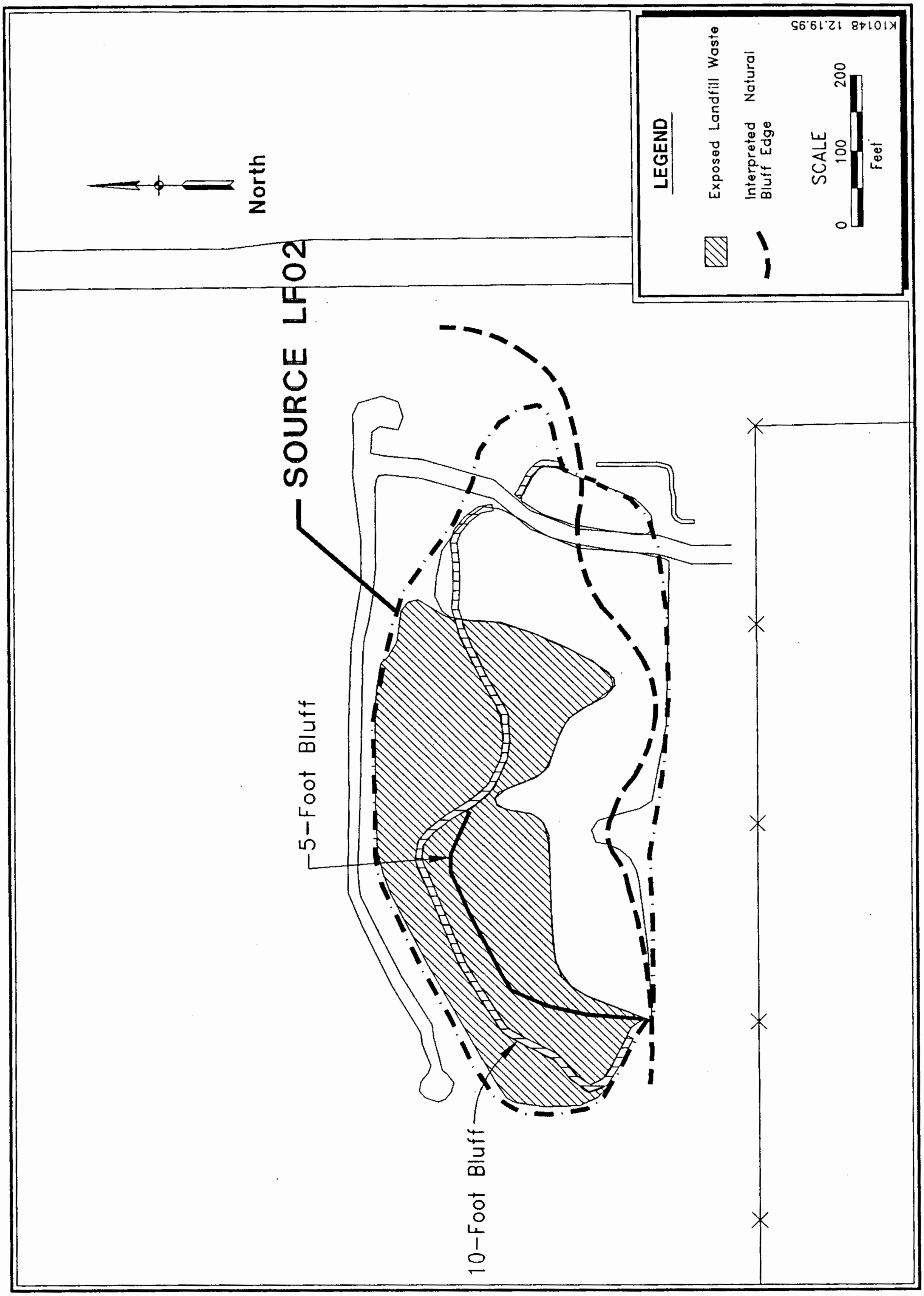


**Figure 5.3-2. Areas of Exposed Landfill Waste at LF02**

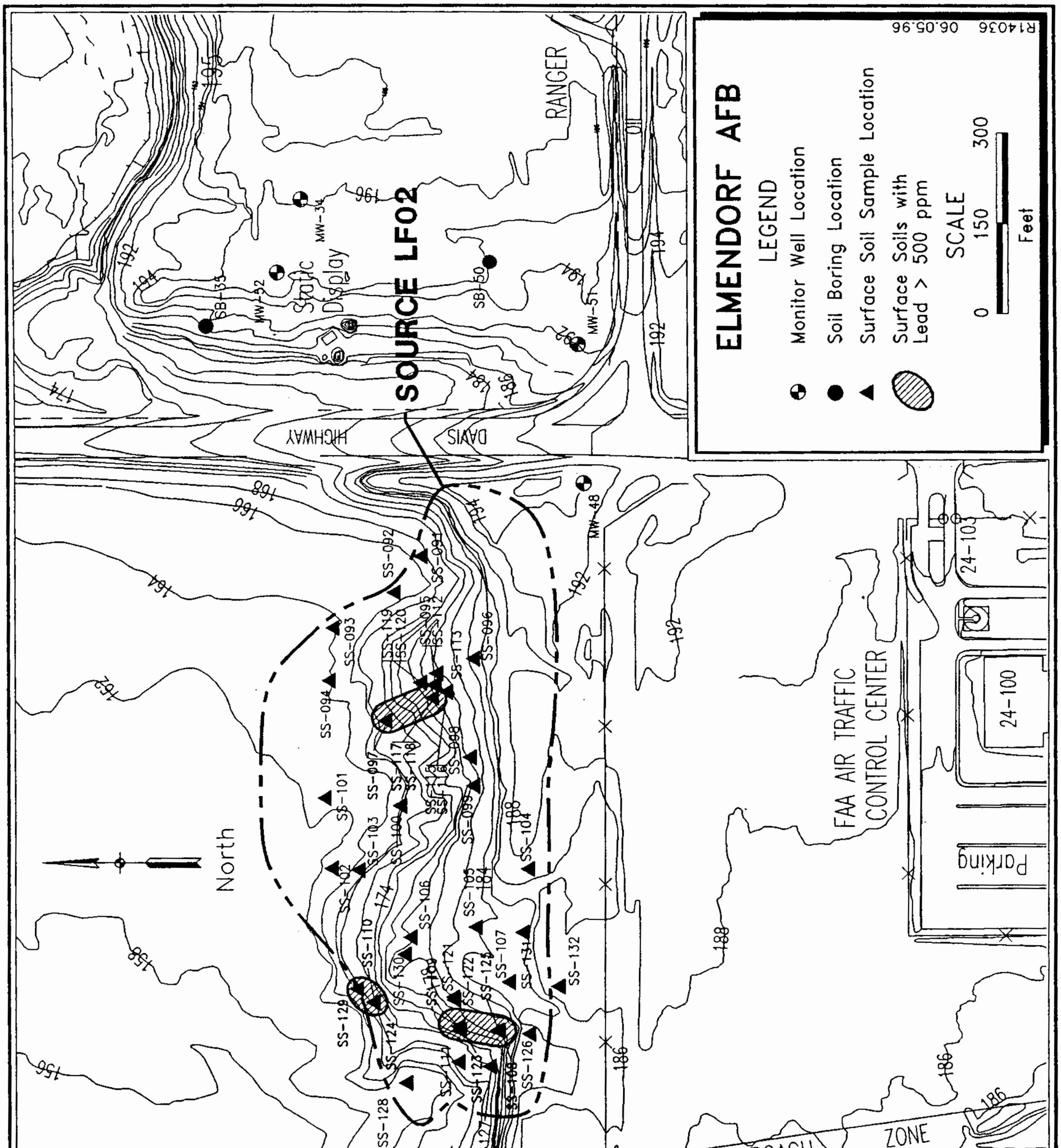


Figure 5.3-3. Areas of Soil Contamination at LF02

The OU 6 Proposed Plan identified DRO and GRO as soil constituents exceeding regulatory levels. This fuel-related soil contamination was detected only at static display locations. GRO and DRO were not identified as COCs since the contamination is several tens of years old, and that there is no evidence that it has impacted groundwater during the 40 years since the former gun battery was decommissioned. Metals other than lead were also detected in the soils, but their contribution to health risk was insignificant and the levels detected were at or near background concentrations. Thus, lead is the only chemical-specific COC for soil at LF02.

**Summary**

Actual or threatened releases of hazardous substances from LF02, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment.

## 5.4 Remedial Action Objectives, Alternatives, and Comparative Analysis for LF02

The following subsections discuss the remedial action objectives for LF02, and present a description of the various alternatives which were evaluated to achieve those remedial objectives. The results of the detailed comparison made between those alternatives are also presented.

### 5.4.1 Remedial Action Objectives

Specific remediation alternatives were developed and evaluated for the areas with potential risk and that exceeded the preliminary remediation goals identified in Section 5.3.3. Specific remedial action objectives (RAOs) for LF02 are as follows:

- Prevent the ingestion and dermal contact of water, and inhalation of vapors while bathing, for water having 1,1,2,2-tetrachloroethane in excess of cleanup goals and/or resulting in a cancer risk greater than 1.0E-06.

- Mitigate to the extent practicable human dermal exposure with lead contaminated shallow soils and exposed landfill waste or debris present on the landfill surface.

- Preserve existing vegetation and ecological habitat to the extent practicable.

### 5.4.2 Groundwater Alternatives

As discussed in Section 5.3.3, the primary COC is a halogenated volatile organic compound (HVOC) in groundwater. The four most promising groundwater alternatives ("G") were chosen on the basis of the nine CERCLA criteria. These included the following: no action (G1); long-term monitoring with institutional controls (G2); pump and treat with institutional controls and long-term monitoring (G3); and air sparging with institutional controls and long-term monitoring (G4). Descriptions of Alternatives G1, G2, and G3, methods for determining time to complete cleanup, and an explanation of cost estimates are included in Section 2.4.2.

Alternative G1 for LF02 is identical to G1 for WP14/LF04 South. Alternative G2 does not require product removal for LF02 as it does for WP14/LF04 South, but otherwise this alternative is identical between these sites. Alternative G3 for LF02 differs in that air stripping would not be included, product would not be recovered, and water would be discharged to a nearby storm sewer. Alternative G4 is completely different for LF02; therefore, it is described below. Table 5.4-1 summarizes the cleanup times and costs for the LF02 groundwater alternatives.

Table 5.4-1

**Costs and Time to Cleanup for Groundwater Alternatives for LF02**
**Elmendorf AFB, AK**

| Alternative | Costs (Thousands of $) | | | Time to Cleanup (years) |
|---|---|---|---|---|
| | Capital | Annual O&M[a] | Present Value[b] | |
| G2 | 1.71 | 28.3 | 383 | 23 |
| G3 | 488 | 32.4 | 788 | 0.3 |
| G4 | 188 | 40.5 | 496 | 0.3 |

a O&M = Operation and maintenance
b Present value discount rate = 5%

**Alternative G4: Air Sparging with Institutional Controls and Long-Term Monitoring**

In Alternative G4, air sparging wells would be installed in the area of contaminated groundwater. Air would be injected into the wells and sparged (blown) into the groundwater below the water table. As the air passes through the contaminated groundwater, the contaminants of concern would be stripped from the water phase into the gas phase.

In addition, some of the oxygen would dissolve into the groundwater, creating an aerobic environment that would enhance biodegradation of some of the remaining contaminants. Some of the contaminants could migrate to the land surface and be emitted to the atmosphere. This alternative also includes land use restrictions and the monitoring program described in Alternative G2 (Section 2.4.2). When two consecutive monitoring events indicate contaminant levels are below cleanup levels, the air sparging system would be turned off. Semi-annual sampling would continue for one more year. The sample results would be evaluated to determine if the contaminated concentrations had remained below cleanup levels. If so, the treatment system would be discontinued and no further remedial action would be required. If contaminant concentrations had rebounded, the treatment system would be restarted.

### 5.4.3 Summary of Comparative Analysis of Groundwater Alternatives

The comparative analysis describes how each of the groundwater alternatives meet the CERCLA evaluation criteria relative to each other.

**Threshold Criteria**

Threshold criteria are those that must be met for the alternative to be viable and relate directly to the statutory determinations discussed in Section 5.5.1. This category includes two criteria: overall protection of human health and the environment and compliance with ARARs.

**Overall Protection of Human Health and the Environment**--Alternative G1 (No Action) was the only alternative that failed to meet this criterion. This failure was a result of the alternative not satisfying the RAOs for protection of human health. This alternative is therefore the least protective.

Alternatives G2, G3, and G4 all meet this criterion since they each monitor the reduction of contaminants to acceptable levels through active treatment or natural processes. These alternatives all satisfy this criterion to slightly different degrees. All of the alternatives comply with ARARs. The primary differences among Alternatives G2, G3, and G4 are: (1) the risks to workers and the community during implementation of the alternative; (2) the construction and operation requirements of the alternatives; and (3) Alternative G2 has a longer remediation time. Alternative G2 poses no additional risks to workers and the community and has no construction or operational requirements, except those associated with a groundwater monitoring program. Alternative G3 and G4, on the other hand, involve the extraction of contaminants, and therefore have an increased risk to workers and community. Workers also incur physical and contaminant exposure risks during the construction and operation of remedial equipment in these alternatives. These risks are considered very minor and manageable; however, the remedial actions associated with these risks would only slightly reduce the overall risk at LF02 and thus provide little benefit.

**Compliance with ARARs**--The cleanup level for 1,1,2,2-tetrachloroethane is not an ARAR, but rather a risk-based remediation goal of 0.43 $\mu$g/L. There are no chemical-specific ARARs associated with this remedial goal. Alternatives G2, G3, and G4 will eventually completely meet this goal, but only Alternatives G3 and G4 include active treatment. Alternative G1 does not include a monitoring program; therefore, it would not be known if and when contaminant concentrations attenuated to meet the cleanup goal.

No location-specific ARARs were identified for this site; therefore, there is no difference among the alternatives with regards to these ARARs.

Action-specific ARARs would be satisfied for each of the alternatives, so Alternatives G1, G2, G3, and G4 each meet this criterion for action-specific ARARs. There are fewer action-specific ARARs associated with Alternatives G1 and G2, making them more preferable than Alternatives G3 and G4. Alternative G3 would involve complying with federal and state wastewater discharge regulations, and Alternative G4 has air emission limitations requiring compliance. Compliance for both of these alternatives should be readily achieved but would require more effort than Alternatives G1 and G2.

**Balancing Criteria**

Balancing criteria are the primary basis for comparing alternatives. These criteria relate the alternative to the site-specific conditions. The no action alternative (G1) is not evaluated based on the balancing criteria or the modifying criteria, since it did not meet both threshold criteria. Balancing criteria includes long-term effectiveness and permanence; reduction in toxicity, mobility, and volume through treatment; short-term effectiveness; implementability; and cost.

**Long-term Effectiveness and Permanence**--This criterion has to do with long-term protection of human health and the environment (reduction of risks), and adequacy and reliability of controls. Long-term management ("controls") would include a five-year review, land use restrictions, and semi-annual (twice per year) groundwater monitoring. Alternatives G2, G3, and G4 all fully meet this criterion, since each alternative includes effective long-term management and permanent reduction of risks through elimination of contamination. The residual risk and long-term monitoring requirements for these alternatives are very similar, and do not have any significant differences.

**Reduction in Toxicity, Mobility, and Volume Through Treatment**--Alternatives G3 and G4 fully meet this criterion since both include active treatment processes to remediate groundwater contaminants. Both provide an active treatment technology that would reduce the toxicity, mobility, and volume of contaminated media. Alternative G2 does not satisfy this criterion because it does not propose an active treatment.

**Short-term Effectiveness**--This criterion evaluates risks to workers, the community, and the environment during the period of time until remedial action objectives are met. Alternatives G2, G3, and G4 each meet this criterion since each provide adequate protection and risk reduction while groundwater contaminants are being reduced to acceptable levels. Even though it has a longer remediation time, Alternative G2 is considered the most effective in the short term because it involves no additional risks to workers or the community during implementation and operation.

Alternatives G3 and G4 have little differences with regards to short-term effectiveness. They both have the same anticipated remediation times and pose minor risks to workers and the community during construction and operation of remedial equipment. Alternative G4 may be considered slightly less effective because it discharges contaminants to the atmosphere, whereas Alternative G3 captures them on carbon prior to destruction in a commercial incinerator.

**Implementability**--Each of the alternatives is considered fully implementable at LF02; therefore, G2, G3, and G4 each fully meet this criterion. Alternative G2 is considered the most implementable, followed by Alternatives G4 and G3, respectively. Alternative G2 would not require the construction or operation of remedial equipment. However, it has the least reliable technology. The calculated rate of natural contaminant reduction has substantial uncertainties; therefore, the reliability of this action has substantial uncertainties. Alternative G3 and G4 have actions requiring construction and operation of equipment, making them more difficult to implement. In terms of the reliability of the technologies, Alternative G3 uses conventional pump-and-treat methods which historically have had difficulties in achieving drinking water standards particularly in locations where contamination is wide spread and at low concentrations. Alternative G4 uses a newer technology, which may be slightly less reliable.

**Cost**--Alternative G1 does not have any costs associated with it. The next least expensive alternative is G2 ($383K), followed by G4 ($496K) and G3 ($788K). All costs are in present value.

**Modifying Criteria**
Modifying criteria consider state and community concerns.

**State Acceptance**--The State of Alaska has been involved in the development of alternatives for LF02 and concurs with the USAF and the USEPA in the selection of Alternative G2, long-term monitoring with institutional for groundwater at LF02. The Air Force will investigate and implement other remedial alternatives should the selected remedy prove to be unsuccessful at meeting the required cleanup levels.

**Community Acceptance**--All the alternatives were presented to the community in the Proposed Plan. Based on the comments received during the public comment period, the public has no preference of alternatives.

### 5.4.4 Soil Alternatives

As discussed in Section 3.3.3, the only COCs for LF02 soils are the exposed landfill waste and lead in the shallow soils. Only two alternatives were evaluated: no action (S1); and limited soil cover with removal of surface debris and institutional controls (S2). Lead was not retained as a COC in the FS; therefore, this alternative did not originally include a soil cover. However, a limited soil cover was added to this alternative following the Proposed Plan based upon evaluation of additional data and a comment received from ADEC during the public comment period.

**Alternative S1: No Action**

Evaluation of this alternative is required by CERCLA as a baseline reflecting current conditions without any cleanup. This alternative is used for comparison with the other alternative. This alternative does not include long-term monitoring, controls, or access restrictions; therefore, potential exposure pathways would not be eliminated. There are no costs associated with this alternative.

**Alternative S2: Limited Soil Cover with Removal of Surface Debris and Institutional Controls**

This alternative includes placing 2 feet of soil over three areas with elevated lead concentrations in the shallow soils (Figure 5.3-3). Additionally, any landfill debris on top of or protruding from the ground at LF02 will also be removed. The soil cover will protect visitors to the site from exposure to the lead contaminated soils. Additionally, removal of the surface debris will mitigate exposure to landfill debris without impacting the existing vegetation. LF02 is currently designated as a "restricted use area" in the Base Comprehensive Plan. This designation provides for recreational use of the parcel (cross country skiing, etc.) and for construction of unmanned facilities such as a parking lot, storage building, or taxiway, but prohibits the construction of any sort of manned facility such as an office building or a residence. As a former landfill, LF02 will maintain this designation indefinitely. No further action would be required as a means of closing the LF02 landfill. The cost for Alternative S2 is $74,100. There are no annual O&M costs associated with this alternative.

### 5.4.5 Summary of Comparative Analysis of Soil Alternatives

The placement of the soil cover may impact existing vegetation in some areas, but because of the limited nature of this action, the RAO of preserving existing habitat to the extent practicable is considered met. Additionally, removal of surface debris will minimally impact the vegetation and ecological habitat while meeting the RAO of mitigating human exposure potential. Limited soil cover with removal of surface debris and institutional controls is considered to be the sole practical remedy, because more aggressive actions would damage the existing habitat. The addition of a limited soil cover is based upon a comment received from ADEC during the public comment period. ADEC has indicated this approach would be compliant with ARARs concerning applying a final cover to landfilled wastes; doing so will achieve relevant and appropriate state standards for landfill closure (18 AAC 60.390). The community did not express a preference of alternatives during the public comment period on the Proposed Plan.

### 5.5 Selected Remedy for LF02

The selected remedy for LF02 includes Alternatives G2 and S2 (long-term monitoring with institutional controls for groundwater, and limited soil cover with removal of surface debris and institutional controls for soils). The selected remedy is hereafter referred to as Alternative G2/S2. Alternative S2 is the sole practical remedy for mitigating exposure to landfill waste and lead contaminated shallow soils, because it removes or covers the majority of the waste with minimal impact to the existing vegetation and habitat. It is also acceptable to the public and the State of Alaska.

Alternative G2 best meets the nine CERCLA criteria. It protects human health and the environment, and complies with ARARs. It is effective at reducing contamination both in the short term and long term, and is implementable, cost-effective, and acceptable to the public and the State of Alaska. This alternative provides an appropriate level of risk reduction measures and compliance with ARARs. Modeling showed that groundwater cleanup can occur within a reasonable time (23 years). The known sources of contamination have been controlled, so they are no longer a threat. This remedy will naturally degrade the residual contamination.

Alternative G2/S2 was selected because it provides the following specific benefits at LF02:

- Alternative G2 is the most cost effective alternative for groundwater. It costs less than Alternatives G3 and G4, and it does not involve additional risks to workers or the community.

- Institutional controls will protect against potential risk to human health by reducing the possibility that contaminated shallow aquifer groundwater will be consumed by people until cleanup levels are met.

- Covering contaminated surface soils and removing exposed landfill wastes will protect human health while causing minimal ecological impacts.

- Alternative S2 will substantively comply with 18 AAC 60.390.

Specific components of the selected remedy are illustrated in Figure 5.5-1 and consist of the following:

**Groundwater at LF02 (Including Seeps):**

- Access to groundwater at LF02 will be institutionally controlled. LF02 is currently designated as a "restricted use area" in the Base Comprehensive Plan. This designation provides for recreational use of the parcel (cross country skiing, etc.) and for construction of unmanned facilities such as a parking lot, storage building, or taxiway, but prohibits the construction of any sort of manned facility such as an office building or a residence. Drilling into the shallow aquifer is also restricted by the Base Comprehensive Plan. As a former landfill, LF02 will maintain this designation indefinitely.

- Groundwater will be monitored semi-annually and evaluated annually to determine contaminant migration and to track the progress of contaminant degradation and dispersion, as well as to provide an early indication of unforseen environmental or human health risk. Five-year reviews will also assess the protectiveness of the remedial action, including an evaluation of any changed site conditions, as long as contamination remains above cleanup levels.

- Groundwater monitoring will be discontinued if contaminant levels are below cleanup levels during two consecutive monitoring events. In that case, no further action for groundwater will be required.

- During the last round of groundwater monitoring, samples will be collected and analyzed for all constituents that exceeded MCLs during the 1994 investigation, including VOCs and SVOCs. These results will be evaluated before a final determination is made that groundwater meets all cleanup requirements.

- All groundwater is expected to be cleaned up within 23 years.

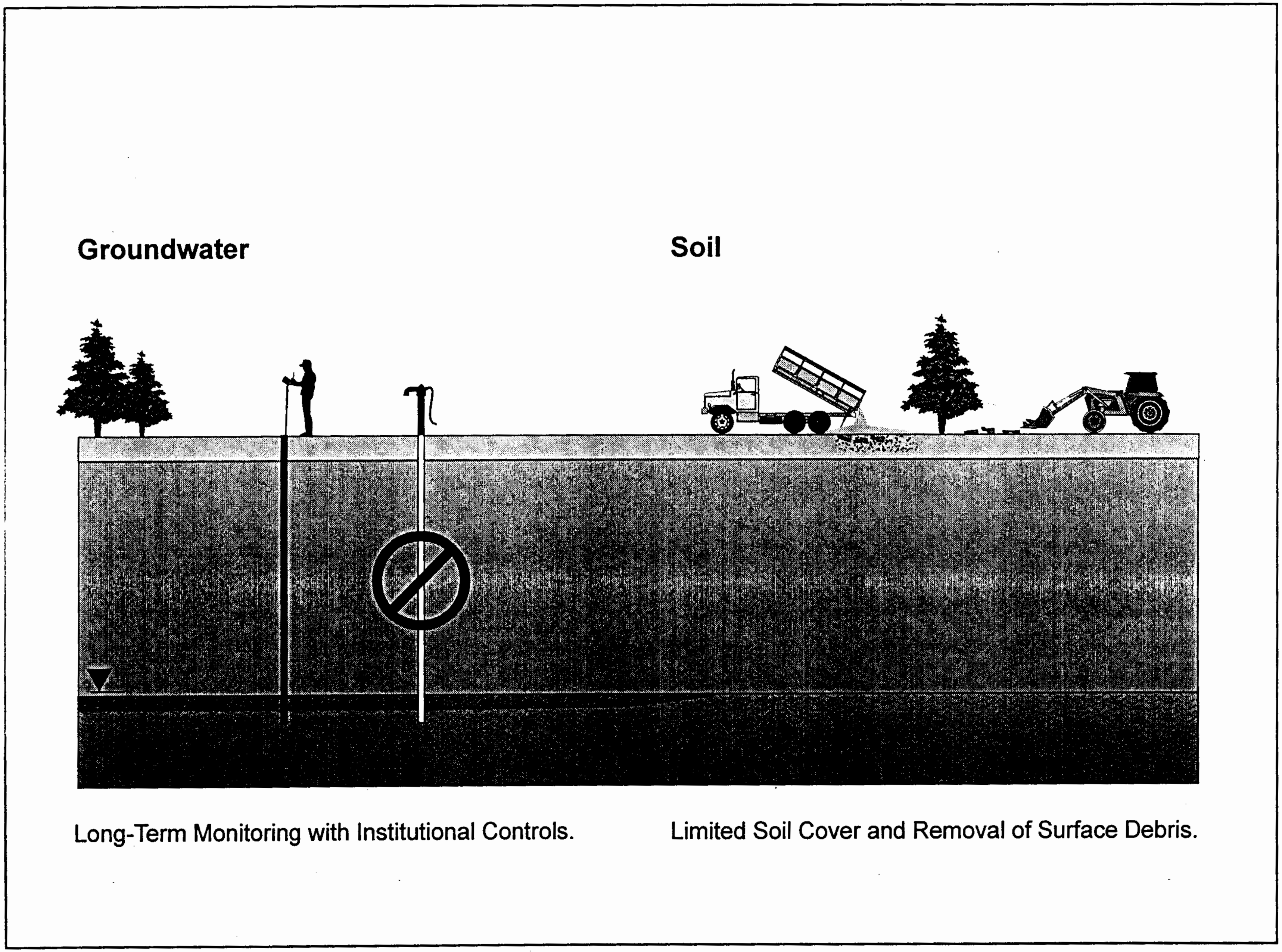


**Figure 5.5-1. Selected Alternatives for LF02**

**Soil at LF02:**

- Access to soil at LF02 will be institutionally controlled. LF02 is currently designated as a "restricted use area" in the Base Comprehensive Plan. This designation provides for recreational use of the parcel (cross country skiing, etc.) and for construction of unmanned facilities such as a parking lot, storage building, or taxiway, but prohibits the construction of any sort of manned facility such as an office building or a residence. As a former landfill, LF02 will maintain this designation indefinitely.

- A limited soil cover will be applied in three areas with elevated lead concentrations at LF02. This will eliminate the pathway for contact with the lead contamination. Five-year reviews will be conducted to evaluate the integrity of the cover, evaluate impacts from any changed site conditions, and assess the continued protectiveness of this remedial action.

- Landfill debris on top of or protruding from the ground surface at LF02 will also be removed as part of the specific remedy for this area.

- Hazardous materials encountered during the removal event will be handled according to appropriate regulations.

- No further action will be required as a means of closing the LF02 landfill.

The actual time frame for natural contaminant degradation is not known, but groundwater modeling predicts cleanup levels will be achieved in about 23 years. Groundwater and seeps will be monitored to evaluate the progress of degradation and dispersion. Further response actions, coordinated with the regulatory agencies, may be considered if monitoring finds unacceptable contaminant migration occurring, or unacceptable reduction in contaminant concentrations.

Because the remedy will result in contaminants remaining on-site above health based levels, a review will be conducted within 5 years after commencement of remedial action. The review will ensure that the remedy continues to provide adequate protection of human health and the environment.

The selected remedy includes provisions for the preparation of a workplan for continued environmental monitoring of the affected media. This workplan will include specific details regarding the number and location of monitoring points, as well as guidelines for eliminating select monitoring points as cleanup occurs. Environmental monitoring will be discontinued at LF02 when the remediation goals have been satisfactorily achieved. This determination will be made jointly by the USAF, the USEPA, and the State of Alaska pursuant to the Federal Facility Agreement.

### 5.5.1 Statutory Determinations

The selected remedy satisfies the requirements under Section 121 of CERCLA to:

- Protect human health and the environment;

- Comply with ARARs;

- Be cost effective; and

- Utilize permanent solutions and alternative treatment technologies to the maximum extent practicable.

**Protective of Human Health and the Environment**

The selected remedy is protective of human health and the environment. Risk to human health from the exposed landfill waste and lead contaminated shallow soils will be reduced by removing the landfill waste and placing a clean soil cover over the lead contaminated areas. There are no current points of exposure for the contaminated groundwater. The potential for exposure to contaminated seeps is very low. Institutional controls will protect against the potential risks by assuring that contact with the contaminated media is minimized until RAOs have been met.

Risks were calculated using assumptions regarding exposure pathways and the time receptors were exposed to the contaminants. Each exposure was estimated conservatively in a manner which tends to overestimate the actual risk. Risk management decisions were made considering the uncertainty in the assumptions used in the risk assessment. At LF02, the shallow groundwater is not used and is not expected to be used in the future, so existing risks and potential risks are significantly less than the worst-case risk.

The time required to achieve cleanup levels is not known, but it is estimated to be about 23 years based on statistical analysis of 1994 and 1996 data. Additionally, modeling of contaminant flow at Elmendorf AFB showed that conditions are not expected to deteriorate at LF02. Over time, conditions will improve and the model predicts that cleanup objectives will be met.

**Applicable or Relevant and Appropriate Requirements (ARARs)**

**Chemical-Specific ARARs** --There are no chemical-specific ARARs for the groundwater or soils at LF02. The COC for groundwater, 1,1,2,2-tetrachloroethane, does not have an MCL; therefore, a risk-based goal of 0.43 $\mu g/L$ will be used as a remediation goal to determine if cleanup has been achieved via natural attenuation. This goal is based on risk calculations assuming a residential scenario. Semi-annual groundwater monitoring at LF02 will document the progress towards this goal.

**Location-Specific ARARs** -- There are no specific ARARs which must be met because of the location of the contamination and remedial actions at LF02.

**Action-Specific ARARs** -- The Alaska Solid Waste Management Regulations, Closure Standards for Municipal Solid Waste Landfills (18 AAC 60.390), are relevant and appropriate regulations for LF02. This regulation requires a 24-inch thick cover, or another thickness approved by ADEC, for landfills to be closed. Except for the three areas of surface soils with elevated lead concentrations, ADEC had indicated that the existing cover at LF02 is compliant with state standards for landfill closure (18 AAC 60.390) concerning applying a final cover to landfilled wastes. ADEC has approved the selected remedy of a 2-foot thick soil cover at the three areas with elevated lead concentrations in the surface soils (Figure 5.3-3). This cover does not require grading, but it will be seeded to promote revegetation.

The off-site disposal rule (40 CFR § 300.440) is also relevant and appropriate to the selected remedy. Any hazardous substance, pollutant, or contaminant identified during the implementation of the selected remedy will be disposed of in accordance with this regulation. Action-specific ARARs for LF02 are identified in Table 5.5-1.

**Table 5.5-1**

**Identification of Action-Specific ARARs, LF02**
**Elmendorf AFB, AK**

| Standard, Requirement, Criteria, or Limitation | Citation | Description | Documentation |
|---|---|---|---|
| National Oil and Hazardous Substances Pollution Contingency Plan--Off-Site Disposal Rule | 40 CFR § 300.440 | Establishes procedures for planning and implementing off-site transfer of any hazardous substance, pollutant, or contaminant. | Relevant and appropriate if hazardous substances, pollutants or contaminants are transferred off site during implementation of the selected remedy. |
| **State of Alaska** | | | |
| Alaska Solid Waste Management Regulations | 18 AAC 60.390 | Provides requirements for closure of solid waste municipal landfills. | Requirements are relevant and appropriate to the landfill at LF02. |

AAC - Alaska Administrative Code
CFR - Code of Federal Regulations

### Cost Effectiveness

The selected remedy is the most cost effective of the alternatives because it affords overall effectiveness proportional to its cost. The anticipated remediation time for Alternative G2 is 23 years; therefore, more active remediation would cost more without being significantly more effective. The no action alternative for the soils is less expensive than Alternative S2, but it does not meet the RAOs. Thus, Alternative S2 is the only effective remedy.

### Utilization of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable

The USAF and the USEPA have determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be used in a cost-effective manner at LF02. Of those alternatives that are protective of human health and the environment and comply with ARARs, the USAF and the USEPA have determined that the selected remedy provides the best balance of tradeoffs in terms of long-term effectiveness and permanence; reduction in toxicity, mobility, or volume achieved through treatment; short-term effectiveness; implementability; cost (as discussed in the preceding section); the statutory preference for treatment as a principal element; and considering State and community acceptance. Although the selected remedy does not involve active treatment, it will permanently remove the contaminants through natural, biological break down of the contaminants into harmless chemical compounds, and will permanently remove exposed debris from the site. The State of Alaska concurs with these determinations.

### Preference for Treatment as a Principal Element

Because of the substantial additional cost of actively treating groundwater, the potential for natural degradation in 23 years, and the fact that there are no current receptors of groundwater, long-term monitoring with institutional controls is a more favorable means of addressing groundwater contamination than active treatment. The soil contamination at LF02 (i.e., lead contamination and landfill waste) are not susceptible to treatment; therefore, the waste will be removed and the lead contamination will be covered to prevent exposure.

### 5.5.2 Documentation of Significant Changes

The Proposed Plan lists soil and groundwater contaminants with concentrations in excess of cleanup goals (ACM guidelines and MCLs). This list is different from the COCs established in Section 5.3.3, because identification of COCs includes evaluation of risk along with comparison to cleanup levels. The selected remedy was similar to the preferred alternative presented in the Proposed Plan (Table 7 of the Proposed Plan). The Proposed Plan recommended long-term monitoring of the groundwater and removal of surface debris for the LF02 soils, but the selected remedy also includes a limited soil cover for the lead contaminated shallow soils. The addition of a limited soil cover to address lead in the shallow soil at LF02 is based upon evaluation of additional data and a comment received from ADEC during the public comment period. These changes were a logical outgrowth of the Proposed Plan.

**SECTION SIX**

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# Section 6.0
# SOURCE LF03

The following subsections describe the physical description, land use, groundwater use, and hydrogeology of LF03. The identification of activities which led to the current contamination at LF03 is also included. The discussion of the regulatory and enforcement history of LF03, the role of the response action at LF03, and community participation in the response action are included in the general OU 6 discussion in Section 1.0. The detailed discussion of the hydrogeology at LF03 was combined with the description of the hydrogeology at LF02 and SD73 and is presented in Section 5.1.2. These discussions were combined because of the close proximity between Sources LF02, LF03, and SD73 on the glacial outwash plain.

## 6.1 Site Description

Source LF03 (Figure 6.1-1) consists of a 15-acre landfill located south of Ship Creek. Specifically, this source area is located west of Hospital Drive (west of the hospital housing area), south of Oil Well Road, east of Transformer Street, and north of the sewage meter station. This source area is located on relatively flat terrain at an elevation of 225 feet above mean sea level, where the landfill itself creates a localized topographic high. The regional terrain slopes to the west at about 100 feet per mile. The landfill was operated from 1943 to 1957. General refuse and construction rubble generated from base operations were reportedly disposed of in this landfill.

Three man-made trenches are also located in the vicinity of LF03. Two of these trenches (approximately 6 feet by 25 feet and 6 by 60 feet) are densely vegetated. The longer of the vegetated trenches had a central berm dividing it into two sections. The third trench (approximately 15 feet by 40 feet) is virtually barren. Both trench and fill, as well as surface dump operations took place at this source area. No daily cover was applied at the landfill, and some open burning reportedly took place during the 1950s. As a result of complaints about odor and nuisance, the landfill was closed in 1957. It was covered with several feet of local soil, which now supports a substantial growth of trees and shrubs (USAF, 1996).

### 6.1.1 Land Use

LF03 is currently designated as a "restricted use area" in the Base Comprehensive Plan. This designation provides for recreational use of the parcel (cross country skiing, etc.) and for construction of unmanned facilities such as a parking lot, storage building, or taxiway, but prohibits the construction of any sort of manned facility such as an office building or a residence. Drilling into the shallow aquifer is also restricted by the Base Comprehensive Plan. As a former landfill, LF03 will maintain this designation indefinitely. Permanent inclusion in the "accident potential zone" further restricts the construction of any aboveground facilities at this location.

There are no known historic buildings, archeological sites, wetlands, floodplains, or rare or endangered species at LF03.

### 6.1.2 Hydrogeology and Groundwater Use

The discussions of the geologic and hydrogeologic settings for Sources LF03, LF02, and SD73 have been combined because of their similar hydrogeologic regimes and close proximity on the glacial outwash plain. The general site map for LF03 is presented as 6.1-1. The hydrogeologic conceptual model for LF03, showing the main hydrostatigraphic units in the area, is presented as

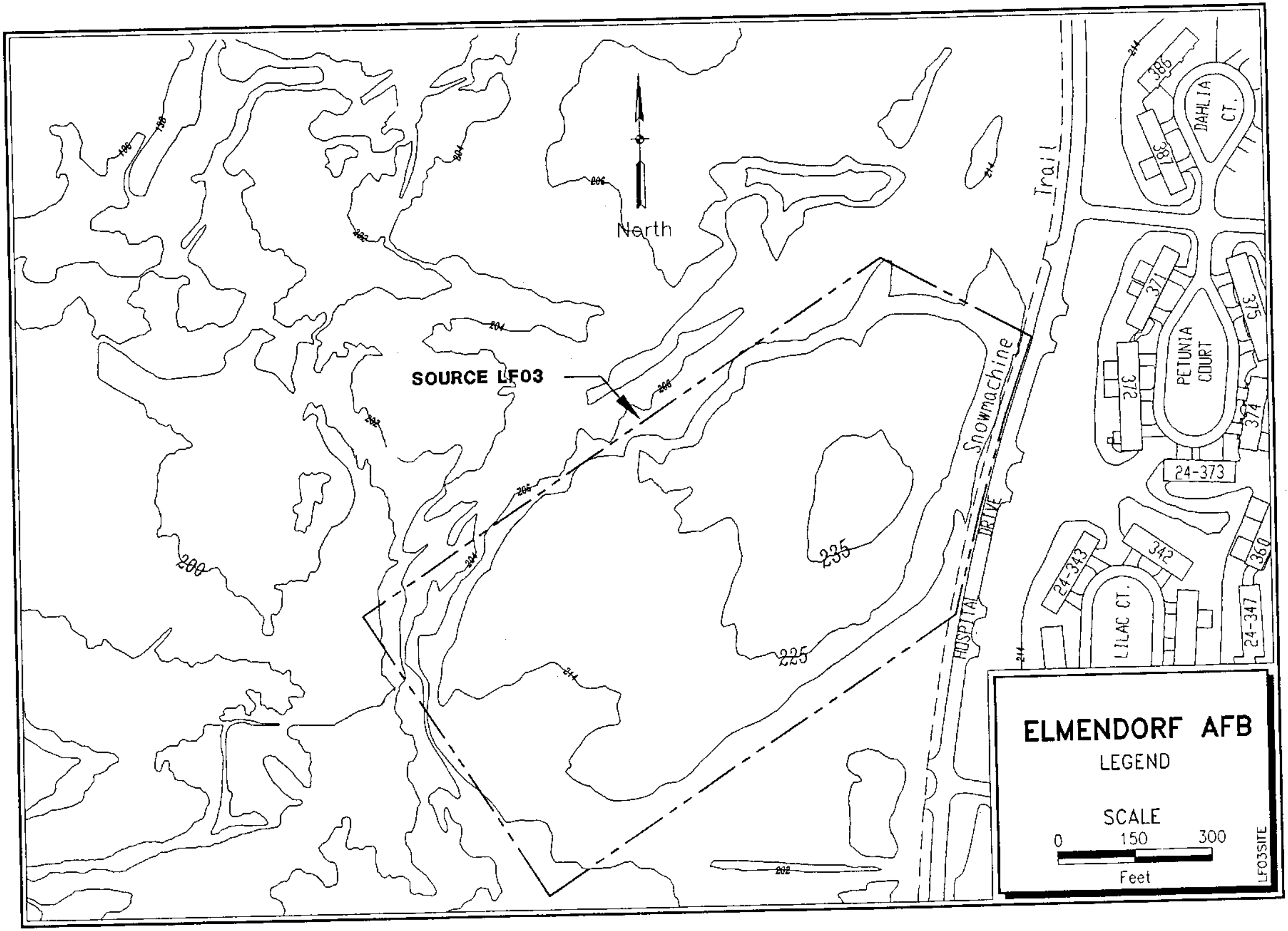


Figure 6.1-1. Location Map for Source Area LF03

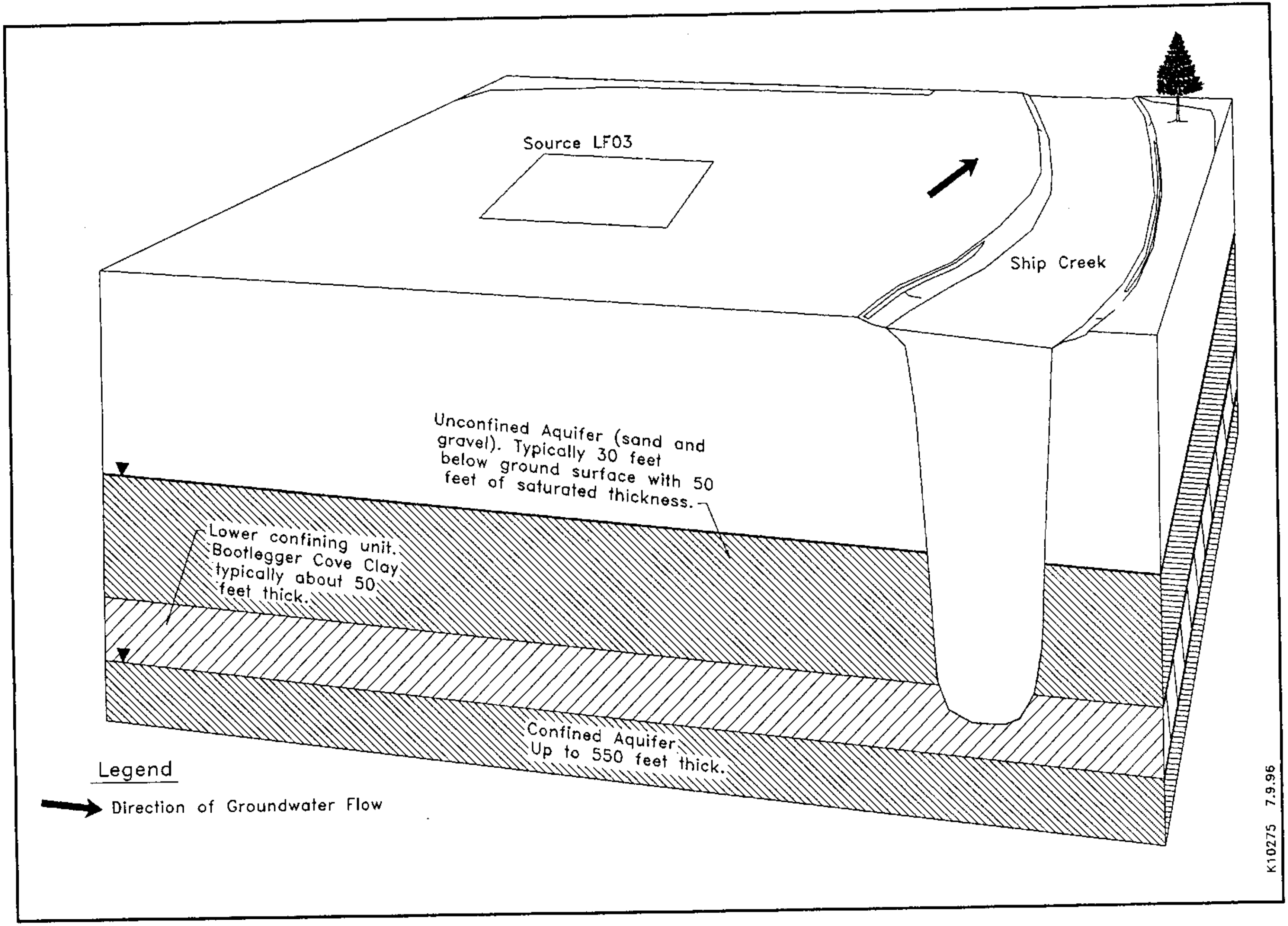


Figure 6.1-2. Conceptual Hydrogeologic Model for LF03

Figure 6.1-2. For a more general description of Elmendorf AFB geology and hydrogeology see Section 1.0 of this document, or the OU 6 RI/FS (USAF, 1996).

The groundwater in the shallow aquifer at LF03 is not used for any purpose on base. Its future use, even if the aquifer was uncontaminated, is generally limited because of the higher yield of the deeper confined aquifer below the Bootlegger Cove Clay.

## 6.2 Site History and Enforcement Activities

The following section identifies the activities which led to the current contamination at LF03. The regulatory and enforcement history for LF03 is included in the general discussion presented for OU 6 in Section 1.0, as are the discussions of the role of the response action and the community participation in the response.

### 6.2.1 Identification of Activities Leading to the Current Contamination at LF03

Significant contamination at LF03 is limited to groundwater only, since the landfill itself has been capped. Significant contamination was also not identified in any of the trenches around LF03.

Constituents detected in the groundwater at LF03 are primarily metals. However, all of the metals detected are at background concentrations. Low levels of other constituents below MCLs, primarily solvents, were also detected in the groundwater. Specific sources were not identified for these constituents. A schematic of the migration path these low level solvents and metals may take through the soil and into the groundwater is presented as Figure 6.2-1.

Prior to the RI conducted at LF03 in 1994, LF03 had been addressed under the following studies:

- IRP Phase I/II Records Search and Statement of Work (Engineering-Science, 1983);
- IRP Phase II, Stage 3 Work Plan (Harding Lawson, 1988);
- RCRA Facility Assessment Report (ADEC, 1988); and
- IRP Phase III, Stages 3 and 4, Remedial Investigation/Feasibility Study (Black and Veatch, 1990).

Landfilling practices at LF03 were discontinued in 1957 and the area was covered with clean soil. No other sources requiring action appear to be present at this source area.

## 6.3 Site Contamination, Risks, and Areas Requiring Response Actions

This section identifies the areas which were investigated, and those that require remedial action. These areas were chosen based on the risk that contaminants pose to human health and the environment. The basis of this analysis is the data collected during the RI which identified the nature and extent of contamination at LF03.

### 6.3.1 Nature and Extent of Contamination

During the RI, samples of soil and groundwater were collected and analyzed for organic and inorganic constituents. Both organic and inorganic contaminants were detected in the soil and groundwater at LF03. These contaminants include low levels of fuel constituents, VOCs, and metals.

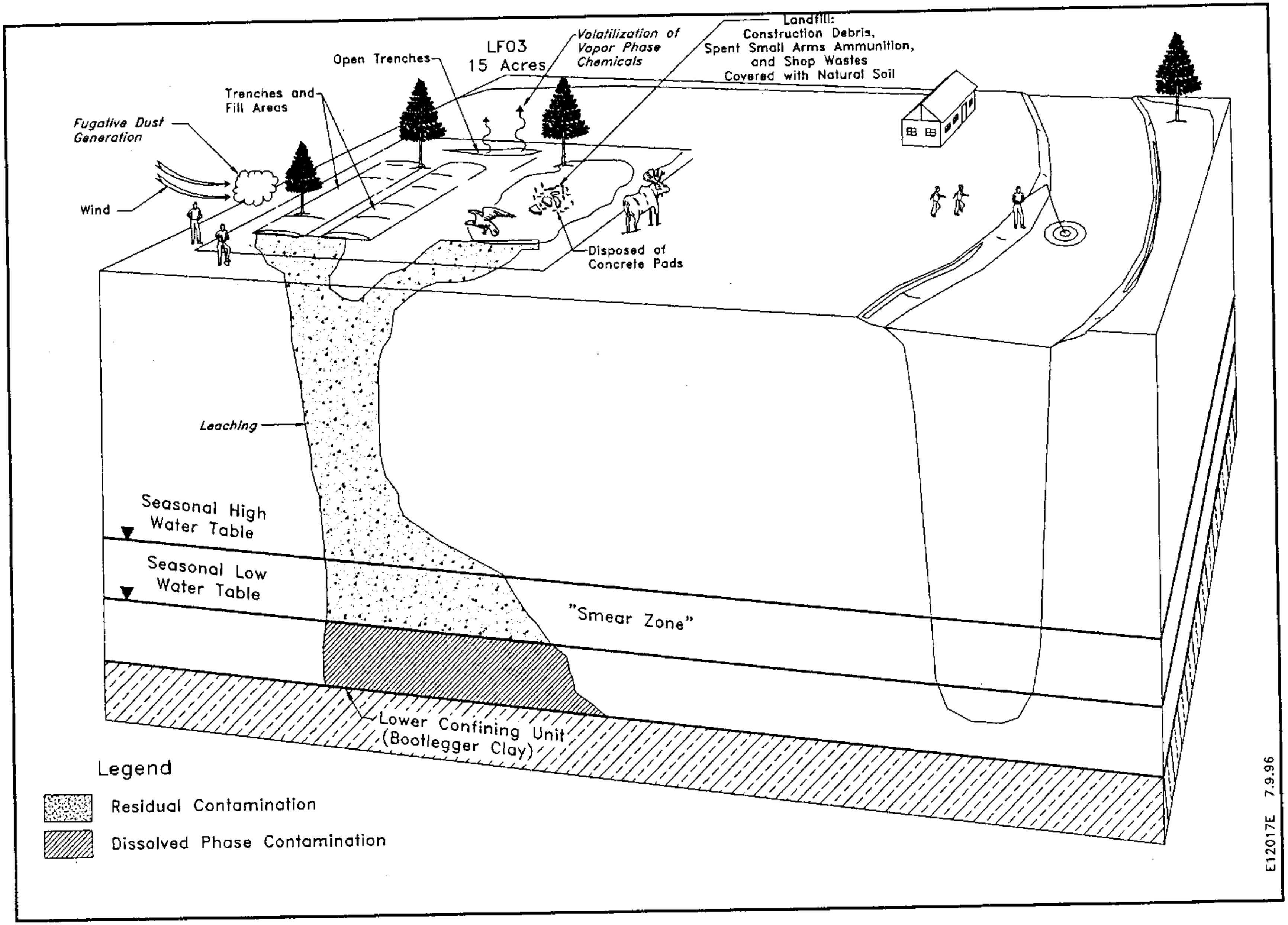


**Figure 6.2-1. Contaminant Release Mechanisms and Pathways for Exposure at LF03 and Adjacent Trenches**





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The contaminations present at LF03 are associated with contaminant transport in the vadose zone, dissolved aqueous transport, and volatilization. These transport mechanisms are pictorially represented for LF03 in Figure 6.2-1.

Tables 6.3-1 through 6.3-3 list the frequency of occurrence and maximum concentrations of all constituents which were detected during the RI in groundwater and soil. The tables do not include results below the detection limit. The MCLs for groundwater and the ACM guidelines for soil are also listed on the tables for all constituents. Results are separated between "indicator parameters" and "contaminant parameters." Indicator parameters primarily include metals classified as nutrients, and non-speciated fuel constituents such as UDRO which are unsuitable for use in a risk-assessment. A detailed discussion of the determination of the COCs for LF03 is presented in Section 6.3.3.

**Groundwater Contamination at LF03**

Groundwater contaminants at LF03 include primarily low levels of fuel constituents, metals, solvents, and other VOCs (Table 6.3-1). The only fuel constituents detected were unidentified organics, which were detected in samples at a maximum concentration of 89.3 $\mu g/L$. The maximum unidentified organic detection was in a sample from MW-32A. The concentrations were flagged as being near the level detected in blank samples. Numerous VOCs including some solvents were detected in the groundwater, but among these, the highest single detection was for acetone, at 11.2 $\mu g/L$. This concentration was flagged as being near blank concentrations. Two SVOCs were detected at low levels, with the highest detection being 10.1 $\mu g/L$ for dimethylphthalate in a sample from MW-32A. In general, organic groundwater contaminant concentrations at LF03, like at LF02, were substantially lower than those previously discussed for source areas WP14, LF04, and SD15.

Numerous metals were also detected in the groundwater at LF03 (Table 6.3-1). As at other OU 6 source areas, a statistical comparison of these metals concentrations was made to available background metals concentration from *Elmendorf Air Force Base, Alaska Basewide Background Sampling Report* (USAF, 1993). Based on this evaluation, all metals evaluated in the groundwater at LF03 were determined to be at or near background concentrations. The summary statistics for the USGS data, including the upper confidence limit concentrations used for these comparisons, are presented in Table 2.3-4.

**Soil Contamination at LF03**

Soil data from LF03 were evaluated based upon surface and subsurface contaminant occurrences. Surface soils include all soils collected from depths shallower than 3 feet bgs. Subsurface soils are those collected from below 3 feet. Tables 6.3-2 and 6.3-3 list the sample depths, maximum concentrations, locations, and guidelines associated with the ACM for non-UST soil for all contaminant parameters in the surface and subsurface soil samples at LF03. Results below the detections limits are not included in the analytical summary tables.

Contamination in the surface and subsurface soils at LF03 occur at concentrations below any other sites previously discussed for OU 6, with the possible exception of LF02. The contaminants present include low levels of metals, fuel constituents, and VOCs.

Metals were frequently detected in the surface and surface soils at LF03. Metals occurrences, via comparison to background results (Table 6.3-2 and 6.3-3), were determined to be at or near background concentrations. Fuel constituents (UGRO and UDRO) were detected in both surface

## Table 6.3-1

## Summary of Groundwater Analytical Results for Source LF03
## Elmendorf AFB, AK

| Method (units) | Analyte | MCL[1] | Maximum Result | Frequency of Detections Total Hits/ Total Samples | Location of Maximum Result |
|---|---|---|---|---|---|
| **Indicator Parameters** | | | | | |
| SW8015ME (µg/L) | Unidentified organics | -- | 51.9 B | 10/10 | MW-32A |
| SW8015MP (µg/L) | Unidentified organics | -- | 89.3 B | 8/10 | MW-32A |
| | Xylene (total) | 10000 | 2.25 | 6/10 | MW-32A |
| SW6010, Total (mg/L) | Aluminum | -- | 89.7 | 10/10 | D3-03 |
| | Calcium | -- | 200 | 10/10 | D3-02 |
| | Iron | -- | 133 | 10/10 | D3-03 |
| | Magnesium | -- | 76.4 | 10/10 | D3-03 |
| | Potassium | -- | 7.77 | 7/10 | D3-03 |
| | Sodium | -- | 25.2 | 10/10 | D3-03 |
| SW6010, Dissolved (mg/L) | Aluminum | -- | 0.0684 B | 2/6 | D3-01 |
| | Calcium | -- | 107 | 6/6 | D3-03 |
| | Iron | -- | 0.23 | 6/6 | D3-03 |
| | Magnesium | -- | 27.2 | 6/6 | D3-03 |
| | Potassium | -- | 1.55 | 4/6 | D3-03 |
| | Sodium | -- | 22.2 | 6/6 | D3-03 |
| **Contaminant Parameters** | | | | | |
| SW8260 (µg/L) | Acetone | -- | 11.2 B | 10/10 | D3-01 |
| | Benzene | 5 | 0.32 B | 6/10 | MW-32A |
| | 2-Butanone(MEK) | -- | 4.97 B | 1/10 | MW-32A |
| | Chloroethane | -- | 0.15 | 1/10 | D3-01 |
| | Chloromethane | -- | 3.34 | 7/10 | D3-01 |
| | Dibromomethane | -- | 0.19 B | 1/10 | MW-32A |
| | 1,2-Dichloroethane | 5 | 2.71 | 1/10[2] | D3-01 |
| | Ethylbenzene | 700 | 1.2 | 1/10 | MW-32A |
| | Methylene chloride | 5 | 1.58 B | 9/10 | D3-01 |
| | 4-Methyl-2-pentanone(MIBK) | -- | 2.92 | 1/10 | MW-32A |
| | Toluene | 1000 | 2.59 | 8/10 | MW-32A |
| | m & p-Xylene | -- | 1.96 | 1/10 | MW-32A |
| | o-Xylene | -- | 0.54 | 1/10 | MW-32A |
| SW8270 (µg/L) | Dimethylphthalate | -- | 10.1 | 2/10 | MW-32A |
| | bis(2-Ethylhexyl)phthalate | 6 | 1.54 B | 1/10 | D3-01 |
| SW8310 (µg/L) | Acenaphthene | -- | 0.54 B | 1/10 | D3-02 |
| SW6010, Total (mg/L) | Antimony | 0.006 | 0.0983 | 1/10 | D3-03 |
| | Barium | 2 | 0.649 | 10/10 | D3-02 |
| | Beryllium | 0.004 | 0.00342 | 9 /10 | D3-03 |
| | Cadmium | 0.005 | 0.00604 | 1/10 | D3-02 |
| | Chromium | 0.1 | 0.165 | 6/10 | D3-03 |
| | Cobalt | -- | 0.0706 | 4/10 | D3-02 |

## Table 6.3-1

## (Continued)

| Method (units) | Analyte | MCL[1] | Maximum Result | Frequency of Detections Total Hits/ Total Samples | Location of Maximum Result |
|---|---|---|---|---|---|
| SW6010, Total (mg/L) (continued) | Copper | 1.3[3] | 0.223 | 6/10 | D3-02 |
| | Manganese | -- | 4.18 | 9/10 | D3-02 |
| | Nickel | 0.1 | 0.23 | 5/10 | D3-03 |
| | Vanadium | -- | 0.254 | 4/10 | D3-03 |
| | Zinc | -- | 0.282 | 8/10 | D3-03 |
| SW7060, Total (mg/L) | Arsenic | 0.05 | 0.0637 | 7/10 | D3-03 |
| SW7421, Total (mg/L) | Lead | 0.015[3] | 0.0558 | 5/10 | D3-02 |
| SW6010, Dissolved (mg/L) | Barium | 2 | 0.0433 | 6/6 | D3-03 |
| | Beryllium | 0.004 | 0.00136 B | 5/6 | D3-01 |
| | Cadmium | 0.005 | 0.00506 | 1/6 | D3-03 |
| | Manganese | -- | 1.45 | 6/6 | D3-03 |
| | Zinc | -- | 0.102 | 1/6 | D3-03 |
| SW7060, Dissolved (mg/L) | Arsenic | 0.05 | 0.00613 | 1/6 | D3-03 |

[1] Maximum contaminant level (MCL); 40 CFR § 141.61 for Federal MCLs, and 18 AAC 80.070 for State MCLs. Federal and State MCLs are identical for the listed constituents.

[2] Frequency "hits" calculation does not include one or more results removed from the data set because they did not meet QA/QC criteria. Total sample count includes all samples analyzed for the indicated parameter.

[3] From 40 CFR, Section 141.11 for inorganics and Section 141.12 for organics (effective 1 July 1991); however, the lead level is effective only until 7 December 1992. There is no longer an MCL for lead or copper (56 Federal Register 26460, June 7, 1991); however, there is an action level of 0.015 mg/L for lead and 1.3 mg/L for copper.

B - Sample concentration was less than or equal to the blank UTL.

# Table 6.3-2

## Summary of Surface Soil Analytical Results for Source LF03
## Elmendorf AFB, AK

| Method (units) | Analyte | ACM Guideline [1] | Background Upper Tolerance Limit | Maximum Result | Depth of Maximum Results (ft) | Frequency of Detection Total Hits/ Total Samples | Location of Maximum Result |
|---|---|---|---|---|---|---|---|
| ***Indicator Parameters*** | | | | | | | |
| D2216 (percent) | Percent moisture | -- | -- | 28 | 2 | 3/3 | MW-33 |
| SW8015ME (mg/kg) | Unidentified organics [UDRO] | 1000 | -- | 4.49 B | 2 | 3/3 | MW-32 |
| SW8015MP (mg/kg) | Unidentified organics [UGRO] | 500 | -- | 43.6 B | 2 | 2/3 | SB-29 |
| SW6010 (mg/kg) | Aluminum | -- | 31183.96 | 22000 | 2 | 3/3 | MW-33 |
| | Calcium | -- | 8013.96 | 7580 | 2 | 3/3 | MW-33 |
| | Iron | -- | 43192.35 | 29300 | 2 | 3/3 | MW-32 |
| | Magnesium | -- | 10904.10 | 8300 | 2 | 3/3 | MW-32 |
| | Potassium | -- | 845.75 | 1000 | 2 | 3/3 | MW-33 |
| | Sodium | -- | 427.05 | 276 | 2 | 3/3 | MW-33 |
| **Contaminant Parameters** | | | | | | | |
| SW8015MP (µg/kg) | Ethylbenzene | -- [2] | -- | 59.3 | 2 | 1/3 | MW-33 |
| | Toluene | -- [2] | -- | 54.4 | 2 | 1/3 | SB-29 |
| | Xylene (total) | -- [2] | -- | 98.5 | 2 | 1/3 | MW-33 |
| SW8240 (µg/kg) | Acetone | -- | -- | 15.5 B | 2 | 1/3 | MW-33 |
| | 2-Butanone(MEK) | -- | -- | 7.83 B | 2 | 2/3 | SB-29 |
| | Methylene chloride | -- | -- | 2.03 B | 2 | 2/3 | SB-29 |
| | m & p-Xylene | -- [2] | -- | 38.2 | 2 | 1/3 | MW-33 |
| | o-Xylene | -- [2] | -- | 14.3 | 2 | 1/3 | MW-33 |
| SW6010 (mg/kg) | Barium | -- | 196.45 | 87.1 | 2 | 3/3 | MW-33 |
| | Beryllium | -- | 0.76 | 0.493 | 2 | 3/3 | MW-32 |
| | Chromium | -- | 48.44 | 33.3 | 2 | 3/3 | MW-33 |
| | Cobalt | -- | 19.52 | 10.4 | 2 | 3/3 | SB-29 |
| | Copper | -- | 31.67 | 36.8 | 2 | 3/3 | SB-29 |
| | Manganese | -- | 929.98 | 560 | 2 | 3/3 | SB-29 |
| | Molybdenum | -- | NA | 1.31 | 2 | 3/3 | SB-29 |
| | Nickel | -- | 50.68 | 30.2 | 2 | 3/3 | SB-29 |
| | Selenium | -- | 0.54 | 6.59 | 2 | 1/3 | SB-29 |
| | Vanadium | -- | 101.64 | 75.9 | 2 | 3/3 | MW-33 |
| | Zinc | -- | 90.01 | 58.5 | 2 | 3/3 | SB-29 |
| SW7060 (mg/kg) | Arsenic | -- | 13.27 | 8.11 | 2 | 3/3 | SB-29 |
| SW7421 (mg/kg) | Lead | -- | 10.69 | 6.23 | 2 | 3/3 | SB-29 |

[1] Alaska Cleanup Matrix (ACM) Level C; 18 AAC 78.315.
[2] The ACM Level C guideline for benzene, toluene, ethylbenzene, and xylenes (BTEX) combined is 50,000 µg/kg.
B - Sample concentration was less than or equal to the blank UTL.
NA - Not applicable.

## Table 6.3-3

### Summary of Subsurface Soil Analytical Results for Source LF03
### Elmendorf AFB, AK

| Method (units) | Analyte | ACM Guideline[1] | Upper Tolerance Limit | Maximum Result | Depth of Maximum Results (ft) | Frequency of Detection Total Hits/ Total Samples | Location of Maximum Result |
|---|---|---|---|---|---|---|---|
| **Indicator Parameters** | | | | | | | |
| D2216 (percent) | Percent moisture | -- | -- | 13.2 | 22 | 16/16 | MW-33 |
| SW8015ME (mg/kg) | Unidentified organics [UDRO] | 1000 | -- | 5.16 B | 22 | 7/7 | MW-32 |
| SW8015MP (mg/kg) | Unidentified organics [UGRO] | 500 | -- | 0.554 B | 22 | 5/9 | SB-29 |
| SW6010 (mg/kg) | Aluminum | -- | 18116.77 | 18700 | 4 | 7/7 | MW-33 |
| | Calcium | -- | 10264.39 | 13200 | 18 | 7/7 | MW-33 |
| | Iron | -- | 38483.64 | 32400 | 4 | 7/7 | MW-33 |
| | Magnesium | -- | 14784.34 | 9880 | 4 | 7/7 | MW-33 |
| | Potassium | -- | 1114.35 | 1180 | 18 | 7/7 | MW-33 |
| | Sodium | -- | 365.59 | 240 | 18 | 7/7 | MW-33 |
| **Contaminant Parameters** | | | | | | | |
| SW8015MP (µg/kg) | Ethylbenzene | --[2] | -- | 120 | 22 | 3/9 | MW-33 |
| | Toluene | --[2] | -- | 19 B | 7 | 7/9 | SB-29 |
| | Xylene (total) | --[2] | -- | 209 | 22 | 3/9 | MW-33 |
| SW8240 (µg/kg) | Acetone | -- | -- | 32.2 B | 12 | 5/9 | MW-32 |
| | 2-Butanone(MEK) | -- | -- | 9.46 B | 7 | 7/9 | SB-29 |
| | Methylene chloride | -- | -- | 3.42 B | 17 | 9/9 | MW-32 |
| | m & p-Xylene | --[2] | -- | 14.4 | 12 | 4/9 | MW-33 |
| | o-Xylene | --[2] | -- | 6.52 | 12 | 1/9 | MW-33 |
| SW6010 (mg/kg) | Antimony | -- | NA | 3.75 B | 16 | 1/7 | MW-33 |
| | Barium | -- | 95.93 | 63.4 | 4 | 7/7 | MW-32 |
| | Beryllium | -- | 0.64 | 0.516 | 4 | 7/7 | MW-33 |
| | Chromium | -- | 76.94 | 39.8 | 4 | 7/7 | MW-33 |
| | Cobalt | -- | 17.62 | 11.6 | 4 | 7/7 | MW-33 |
| | Copper | -- | 59.84 | 46.4 | 4 | 7/7 | MW-32 |
| | Manganese | -- | 709.45 | 611 | 4 | 7/7 | MW-33 |
| | Molybdenum | -- | NA | 1.14 | 19 | 7/7 | MW-32 |
| | Nickel | -- | 71.79 | 36.2 | 4 | 7/7 | MW-32 |
| | Selenium | -- | 0.48 | 5.24 B | 11 | 2/7 | SB-29 |
| | Silver | -- | 1.06 | 0.599 | 4 | 1/7 | MW-33 |
| | Vanadium | -- | 66.16 | 75.1 | 4 | 7/7 | MW-33 |
| | Zinc | -- | 76.17 | 71.7 | 4 | 7/7 | MW-32 |
| SW7060 (mg/kg) | Arsenic | -- | 9.31 | 8.21 | 19 | 7/7 | MW-32 |
| SW7421 (mg/kg) | Lead | -- | 10.13 | 5.37 S | 4 | 7/7 | MW-33 |

[1] Alaska Cleanup Matrix (ACM) Level C; 18 AAC 78.315.
[2] The ACM Level C guideline for benzene, toluene, ethylbenzene, and xylenes (BTEX) combined is 50000 µg/kg.
B - Sample concentration was less than or equal to the blank UTL.
NA - Not applicable.
S - Metal concentration reported was obtained using the method of standard additions.

and subsurface soils; however, the maximum results for each were reported at levels near blank concentrations. A total of eight VOCs were detected in the surface and subsurface soils. The same suite of volatile organics was detected in both soil groups. The maximum VOC concentration detected was xylene, at 209 $\mu$g/kg in a sample from the pilot boring for MW-33.

### 6.3.2 Risk Evaluation

Based on the concentrations of contaminants detected during the RI, human health and environmental risk assessments were performed to determine if areas should be considered for remedial action. All concentrations of contaminants, including all contaminants of concern, whether exceeding MCLs or ACM guidelines or not, were included in the risk assessments. The general discussion of the human health and ecological risk assessment procedures is presented in Section 2.3.2, and will not be repeated since the procedures for each of the source areas within OU 6 were identical. Details on the parameters used in the Health Risk Assessment are shown on Table 2.3-5.

**Human Health Risk Assessment (HRA)**

Since LF03 is not currently used residentially, a *current* residential risk scenario was not evaluated and only current visitor and trench worker scenarios were applied. Even though the future land use at LF03 is restricted as specified in the Base Comprehensive Plan, the *future* residential risk scenario was evaluated at LF03 to obtain the most conservative risk information possible.

ELCRs and HIs were calculated to describe cancer and noncancer risks, respectively. The ELCR is the additional chance that an individual exposed to site contamination will develop cancer during his/her lifetime. It is expressed as a probability such as 1.0E-06 (one in a million). The HI estimates the likelihood that exposure to the contamination will cause some negative health effect. An HI score above one indicates that some people exposed to the contamination may experience at least one negative health effect.

The calculated risks at LF03 are based upon hypothetical exposure to soil and groundwater. The shallow groundwater aquifer at LF03 is not presently used and will not be used in the future for supplying potable or non-potable water. For carcinogenic soil risk, the calculated results for the future resident (RME), construction worker, and visitor are listed. Only the future resident scenario (RME) was used to calculate carcinogenic groundwater risk. Table 6.3-4 summarizes the calculated carcinogenic and noncarcinogenic human health risks calculated for LF03.

Cancer risk using the residential RME scenario for groundwater at LF03 exceeds 1.0E-04. The low levels of 1,2-dichloroethane and beryllium present at the site (both below MCLs) drive this risk. Noncarcinogenic risk above 1.0 was also identified for groundwater at LF03. This risk is driven by the occurrences of beryllium and antimony in the groundwater. No soil risk was identified.

**Ecological Risk Assessment (ERA)**

The ERA was performed to determine if the reported concentrations of chemicals or calculated exposures to plants and wildlife at OU 6 are likely to produce adverse effects. Ecological effects were evaluated quantitatively by calculating Ecological Quotients (EQs). The ERA focused on evaluating potential impacts of the contamination on selected indicator species: the moose, masked shrew, meadow vole, black-capped chickadee, merlin, and peregrine falcon. The general discussion of the ecological risk assessment procedures is presented in Section 2.3.2 and will not be repeated since the procedures for each of the source areas within OU 6 were identical.

## Table 6.3-4

## Summary of Human Health Risks at LF03
## Elmendorf AFB, AK

| Risk | Surface Soil (<3 feet) | | Subsurface Soil | Chemical(s) Driving Risk |
|---|---|---|---|---|
| | Residential Scenario[a] | Visitor Scenario[b] | Trench Worker Scenario[c] | |
| **Soil Risk [d]** | | | | |
| Carcinogenic | NR | NR | NR | NA |
| Non-Carcinogenic | NR | NR | NR | NA |
| **Groundwater Risk [d]** | | | | |
| Carcinogenic | 1.1E-04 | NA | NA | Beryllium<br>1,2-Dichloroethane |
| Non-Carcinogenic | 5.6 | NA | NA | Beryllium, Antimony |

[a] Excess cancer risks conservatively assumed for 30 years of exposure (drinking groundwater, contact with soil, etc.) by future residents (Reasonable Maximum Exposure).
[b] Excess cancer risks conservatively assumed for 30 years of exposure while visiting the site under current conditions.
[c] Excess cancer risks conservatively assumed for 1 year of exposure during on-site construction work (digging, etc.).
[d] Risks are calculated by using the 95% upper confidence limits (UCLs) for contaminants present unless the 95% UCL exceeded the maximum concentration detected, in which case the maximum concentration was used. This represents a conservative estimate of the "worst case" contamination.
NA - Not applicable.
NR - Significant risk not identified.

The calculated ecological quotient (EQ) of 1.0 was exceeded for the black capped chickadee, meadow vole and shrew due to an elevated selenium concentration. The highest selenium EQ was equal to 180 for the masked shrew. EQs were calculated based on surface soil contaminant concentrations. None of the calculated EQs exceeded 1.0 for the moose, peregrine falcon, or merlin at LF03. It is highly likely that the data used to calculate the EQs for selenium at LF03 are not representative of landfill contamination since: (1) the results were collected at locations cross-gradient to and away from the landfill; and (2) there is substantial uncertainty associated with the selenium results based upon the method used and the low levels detected.

**Uncertainties Associated with the Risk Assessment**

The major assumption and uncertainty factors for the OU 6 human health and ecological risk assessments are presented in Section 2.3.2.

### 6.3.3 Conclusions

The following subsections provide a discussion of the determination of COCs for LF03, the location and extent of contamination by any COCs in excess of preliminary remediation goals, and a summary statement about the risk to public health, welfare, or the environment if action is not taken at LF03.

**Contaminants of Concern**

Constituents exceeding preliminary remediation goals (MCLs for groundwater or ACM guidelines for soils) were identified in the Proposed Plan. COCs for OU 6 were developed from the results of the risk assessment and by considering preliminary remediation goals. Each constituent having an individual contribution greater than 1.0E-06 carcinogenic (RME) risk, or an HI greater than 0.1 when the cumulative HI for the site is greater than 1.0, was considered as a COC. In addition, any constituent exceeding preliminary remediation goals (MCLs) for groundwater or ACM guidelines for soil was also considered as a COC.

No COCs were identified for LF03, based upon the above criteria. As noted in Table 6.3-4, three constituents contributed to excess risk in the groundwater at LF03. Antimony was found only at elevated concentrations in samples with high turbidity and therefore was attributed to dissolution of contaminants adsorbed on soil particles in the turbid samples. Beryllium and 1,2-dichloroethane were not identified as COCs because their concentrations were less than MCLs and the cancer risk associated with these constituents was within the acceptable risk range.

The Proposed Plan listed antimony and cadmium as exceeding MCLs in the groundwater at LF03. As previously discussed, antimony was not identified as a COC because of high turbity in the samples. Cadmium was not identified as a COC because the risk assessment indicated no significant risk, and the MCL was only marginally exceeded in a single sample from one well. The RI also identified chromium, nickel, and arsenic as exceeding MCLs. These metals also were not identified as COCs because the risk assessment identified no significant risk and the MCLs were only marginally exceeded. Additionally, all metals in groundwater were determined to be comparable to background concentrations.

**Summary**

No COCs were identified for Source LF03; therefore, there is no risk of imminent or substantial endangerment to public health, welfare, or the environment at this site. As a consequence, no further response action is required.

## 6.4 Remedial Action Objectives, Alternatives, and Comparative Analysis for LF03

The following subsections discuss the remedial action objectives for LF03, and present a description of the various alternatives which were evaluated to achieve those remedial objectives. The results of the detailed comparison made between those alternatives are also presented.

### 6.4.1 Remedial Action Objectives

Remedial action objectives (RAO) are developed based on COCs, potential exposure routes and receptors, and remediation goals. As discussed in Section 6.3.3, the groundwater and soils in LF03 have no COCs; thus, RAOs were not developed for LF03 groundwater or soils.

### 6.4.2 Groundwater Alternatives

Groundwater alternatives are developed to meet RAOs. As discussed in Sections 6.3.3 and 6.4.1, the groundwater at LF03 does not have any COCs or RAOs; therefore, alternatives were not developed for the LF03 groundwater. Consequently, a comparative analysis of groundwater alternatives was not conducted.

### 6.4.3 Soil Alternatives

Soil alternatives are developed to meet RAOs. As discussed in Sections 6.3.3 and 6.4.1, the soils at LF03 do not have any COCs or RAOs; therefore, alternatives were not developed for the LF03 soils. Consequently, a comparative analysis of soil alternatives was not conducted. ADEC has indicated that the existing cover at LF03 is compliant with state standards for landfill closure (18 AAC 60.390) concerning applying a final cover to landfilled wastes.

## 6.5 Selected Remedy for LF03

Access to groundwater and soil at LF03 will be institutionally controlled. LF03 is currently designated as a "restricted use area" in the Base Comprehensive Plan. This designation provides for recreational use of the parcel (cross country skiing, etc.) and for construction of unmanned facilities such as a parking lot, storage building, or taxiway, but prohibits the construction of any sort of manned facility such as an office building or a residence. Drilling into the shallow aquifer is also restricted by the Base Comprehensive Plan. As a former landfill, LF03 will maintain this designation indefinitely. Therefore, the selected remedy for LF03 is as follows:

**Groundwater at LF03:**

- No further action is required for the groundwater at LF03.

**Soil at LF03:**

- No further action is required for the soil at LF03.
- No further action will be required as a means of closing the LF03 landfill.

The State of Alaska concurs with the USAF and the USEPA in the selection of no further action for LF03. Based on comments during the public comment period, the public has no preference.

### 6.5.1 Statutory Determinations

There are no risks to human health or the environment, and no ARARs associated with LF03. Access to groundwater and soil at LF03 will be institutionally controlled. LF03 is currently designated as a "restricted use area" in the Base Comprehensive Plan. This designation provides for recreational use of the parcel (cross country skiing, etc.) and for construction of unmanned facilities such as a parking lot, storage building, or taxiway, but prohibits the construction of any sort of manned facility such as an office building or a residence. Drilling into the shallow aquifer is also restricted by the Base Comprehensive Plan. As a former landfill, LF03 will maintain this designation indefinitely. Therefore, no further action is required.

### 6.5.2 Documentation of Significant Changes

The Proposed Plan lists groundwater contaminants with concentrations in excess of cleanup guidelines. This list differs from the COCs established in Section 6.3.3, because identification of COCs includes evaluation of risk and sample quality along with comparison to cleanup levels. No COCs were identified at LF03. This was a logical outgrowth of the Proposed Plan and did not affect the choice of alternatives at LF03. Therefore, the selected remedy was the preferred alternative presented in the Proposed Plan (Table 7 of the Proposed Plan).

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# SECTION SEVEN

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062867

# Section 7.0
# SOURCE SD73

The following subsections describe the physical description, land use, groundwater use, and hydrogeology of SD73. The identification of activities which led to the current contamination at SD73 is also included. The discussion of the regulatory and enforcement history of SD73, the role of the response action at SD73, and community participation in the response action are included in the general OU 6 discussion in Section 1.0. The detailed discussion of the hydrogeology at SD73 was combined with the description of the hydrogeology at LF02 and LF03, and is presented in Section 5.1.2. These discussions were combined because of the close proximity between Sources LF02, LF03 and SD73 on the glacial outwash plain.

## 7.1 Site Description

Source SD73 (Figure 7.1-1) is located in the glacial outwash plain to the south of Ship Creek. SD73 is located approximately 2400 feet northwest of Source LF03. The topographic elevation at this source area is approximately 205 feet above mean sea level, and the terrain slopes regionally at approximately 100 feet per mile to the west. The area defined as SD73 encompasses a surface disposal area where chemicals from a former United States Geological Survey (USGS) rock testing and film processing laboratory were reportedly discharged onto the ground directly or via open drains. Based upon the architectural style of the buildings at the site, it appears to have been constructed in the late 1940s or early 1950s. The entire facility was occupied by the National Oceanic and Atmospheric Administration (NOAA) around 1977.

This source area was defined as a result of an Environmental Baseline Assessment (EBA) conducted during the summer of 1993 at the facility. Following that study, the surface disposal area surrounding the former USGS rock laboratory was designated as Source SD73 and was added to OU 6.

### 7.1.1 Land Use

Land use for SD73 is light industrial. As mentioned above, the area is included in a facility formerly operated by the USGS and NOAA. Light maintenance shops and a former fueling station, as well as several storage sheds, are located at the facility in the vicinity of SD73. There are no known historic buildings, archeological sites, wetlands, floodplains, or rare or endangered species at SD73. The land use designation may be changed to residential in the future.

### 7.1.2 Hydrogeology and Groundwater Use

The discussions of the geologic and hydrogeologic settings for Sources LF03, LF02, and SD73 have been combined because of their similar hydrogeologic regimes and close proximity on the glacial outwash plain. The general site map for SD73 is presented as Figure 7.1-1. The hydrogeologic conceptual model for SD73, showing the main hydrostratigraphic units in the area, is included with that for LF02, and presented as Figure 5.1-3. For a more general description of Elmendorf AFB geology and hydrogeology, see Section 1.0 of this document or the OU 6 Remedial Investigation/Feasibility Study (USAF, 1996b).

The groundwater in the shallow aquifer at SD73 is not used for any purpose on base. Its future use, even if the aquifer was uncontaminated, is generally limited because of the higher yield of the deeper confined aquifer below the Bootlegger Cove Clay. The fine-grained nature of the aquifer material

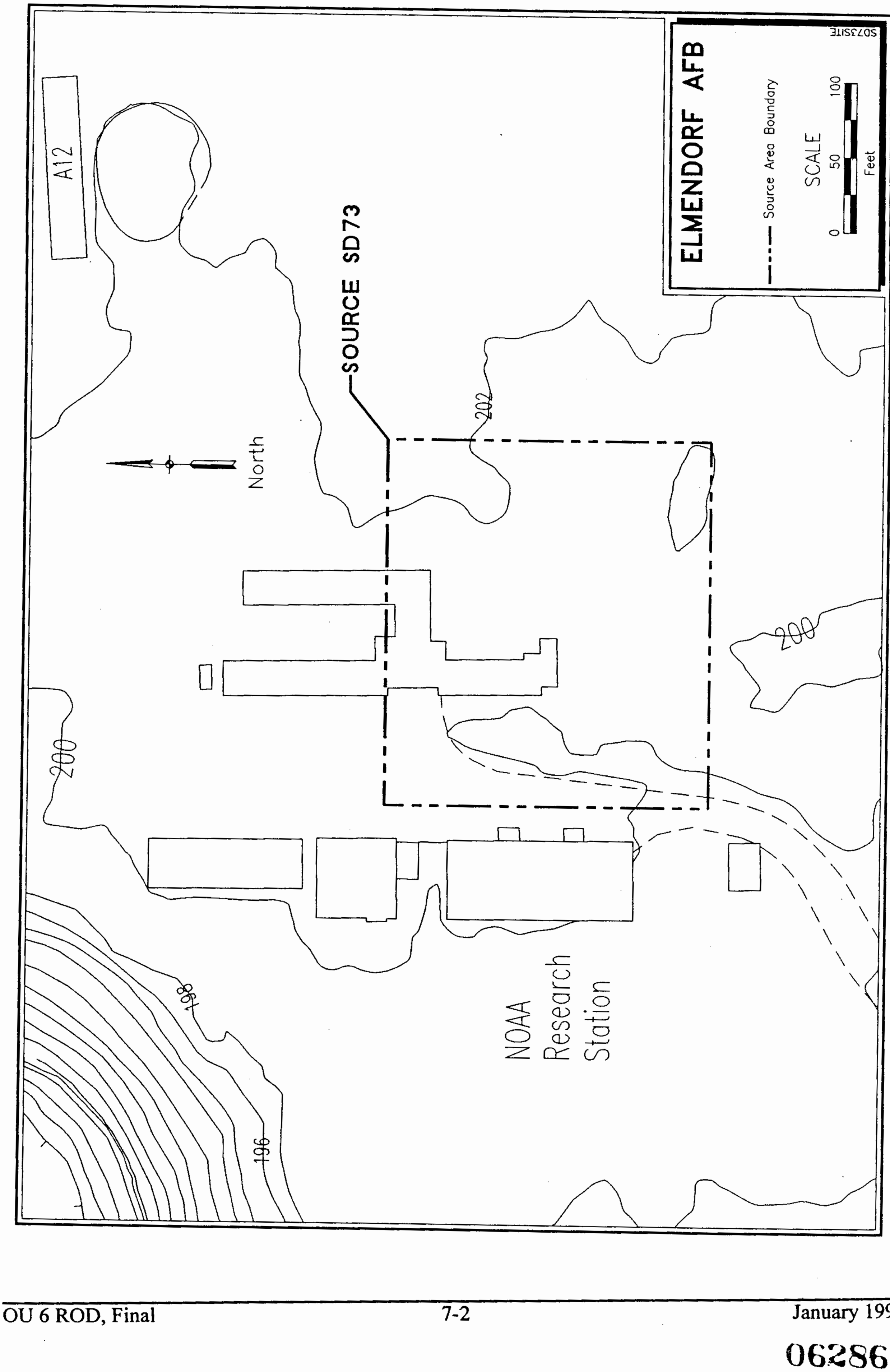


**Figure 7.1-1. Location Map for Source Area SD73**



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at this source area, providing minimal groundwater yield, would make the shallow aquifer at SD73 unsuitable as a drinking water supply aquifer.

## 7.2 Site History and Enforcement Activities

The following section identifies the activities which lead to the current contamination at SD73. The regulatory and enforcement history for SD73 is included in the general discussion presented for OU 6 in Section 1.0, as are the discussions of the role of the response action and the community participation in the response.

### 7.2.1 Identification of Activities Leading to the Current Contamination at SD73

The primary contamination seen at SD73 is associated with the soil, which is contaminated with metals and semi-volatile organic compounds. As with most of the OU 6 source areas, the principal source of contamination at SD73 is previous waste management activities conducted at this location. Laboratory wastes, either passed through open drains onto the ground surface, or dumped in the vicinity of the laboratory facility, have allowed metals and other laboratory wastes to leach into the soil, and potentially impact the groundwater at this source area. A localized dumping area immediately behind the testing laboratory, referred to as a "disposal pit," was also investigated as part of the RI. The contaminants identified in the soils are primarily located in the upper few feet, consistent with the disposal of small quantities of liquid or solid wastes over a fairly long period of time.

Significant contamination at SD73 is limited to the soil only, as the low levels of relatively immobile constituents have not substantially impacted groundwater. In addition, upgradient groundwater results demonstrate the same low level organic compounds as were detected at the downgradient locations. No other sources in the vicinity of SD73 have been identified. Also, no contaminant "smear zone" was detected. A schematic of the potential migration and exposure pathways for constituents from Sources SD73 and LF02 through the soil and potentially into the groundwater is presented in Section 5.2 as Figure 5.2-1.

Prior to the RI conducted at SD73 in 1994, SD73 had been addressed only under one general study, the NOAA Environmental Baseline Assessment (EBA) Work Plan (Radian, 1993) and subsequent EBA Report (Radian, 1993). Rock testing and film processing activities at SD73 were discontinued prior to 1977 when NOAA occupied the facility. No other sources were identified requiring action at this source area.

## 7.3 Site Contamination, Risks, and Areas Requiring Response Actions

This section identifies the areas which were investigated, and those that require remedial action. These areas were chosen based on the risk that contaminants pose to human health and the environment. The basis of this analysis is the data collected during the Remedial Investigation (RI) which identified the nature and extent of contamination at SD73.

### 7.3.1 Nature and Extent of Contamination

During the RI, samples of soil and groundwater were collected and analyzed for organic and inorganic constituents. Both organic and inorganic contaminants were detected in the soil and groundwater at SD73. These contaminants include low levels of volatile organic compounds, including solvents, metals, and SVOCs. The contamination present at SD73 is associated with contaminant transport in the vadose zone, dissolved aqueous transport, and volatilization. These transport mechanisms are pictorially represented for SD73 in Figure 5.2-1.

Tables 7.3-1 through 7.3-3 list the frequency of occurrence and maximum concentrations of all constituents which were detected during the RI in groundwater and soil. The tables do not include results below the detection limit. The MCLs for groundwater and the ACM guidelines for soil are also listed on the tables for all constituents. Results are separated between "indicator parameters" and "contaminant parameters." Indicator parameters primarily include metals classified as nutrients, and non-speciated fuel constituents such as UDRO which are unsuitable for use in a risk assessment. A detailed discussion of the determination of the COCs for SD73 is presented in Section 7.3.3.

**Groundwater Contamination at SD73**

The groundwater constituents detected at SD73 include low levels of several HVOCs as well as BTEX constituents. Low levels of metals were also detected (Table 7.3-1). Among all of the VOCs, the highest concentration detected was for acetone, at 12.8 $\mu$g/L. This concentration was flagged as being near the level detected in blank samples, as were many of the VOC maxima. Two SVOCs were detected, also at low concentrations, with the maximum occurring for dimethylphthalate at 8.18 $\mu$g/L in a sample from well N-3. Like at LF02 and LF03, organic groundwater contaminant concentrations were substantially lower than those previously discussed for source areas WP14, LF04, and SD15.

Four metals, barium, beryllium, manganese, and zinc, were detected at low levels in the groundwater at SD73 (Table 7.3-1). As at other OU 6 source areas, a statistical comparison of these metals concentrations was made to available background metals concentrations. Based upon this evaluation, all metals evaluated in the groundwater at SD73 were determined to be below background concentrations. The summary statistics for the USGS data, including the upper confidence limit concentrations used for these comparisons, are presented in Table 2.3-4.

**Soil Contamination at SD73**

Soil data from SD73 were evaluated based upon surface and subsurface contaminant occurrences. Surface soils include all soils collected from depths shallower than 3 feet bgs. Subsurface soils are those collected from below 3 feet. Tables 7.3-2 and 7.3-3 list the sample depths, maximum concentrations, locations, and guidelines associated with the ACM for non-UST soil for all contaminant parameters in the surface and subsurface soil samples at SD73. Results below the detection limits are not included in the analytical summary tables.

Contamination in the surface and subsurface soils at SD73 was similar to that found at LF03. The contaminants present include low levels of BTEX constituents, metals, VOCs, and SVOCs. Metals were frequently detected in the surface and surface soils at SD73. Metals occurrences, via comparison to background results (Table 7.3-2 and 7.3-3) were determined to be at or near background concentrations. Numerous SVOCs were detected in both surface and subsurface soils; however, each constituent was detected rather infrequently. The maximum SVOC detection was 53.7 mg/kg for bis(2-ethylhexyl)phthalate in a surface sample from A2-HA-3-01. A total of nine VOCs were detected in the subsurface soils and four in the surface soils. BTEX constituents were only detected in the subsurface soils. The maximum VOC concentration detected in the soils was xylene, at 1320 $\mu$g/kg in a sample from soil boring SB-37.

## Table 7.3-1

## Summary of Groundwater Analytical Results for Source SD73
## Elmendorf AFB, AK

| Method (units) | Analyte | MCL[1] | Maximum Result | Frequency of Detections Total Hits/ Total Samples | Location of Maximum Results |
|---|---|---|---|---|---|
| **Indicator Parameters** | | | | | |
| SW6010, Total (mg/L) | Aluminum | -- | 0.239 | 6/6 | N-3 |
| | Calcium | -- | 24 | 6/6 | MW-42 |
| | Iron | -- | 0.237 | 6/6 | N-3 |
| | Magnesium | -- | 5.11 | 6/6 | MW-42 |
| | Sodium | -- | 2.64 | 6/6 | MW-42 |
| **Contaminant Parameters** | | | | | |
| SW8260 (µg/L) | Acetone | -- | 12.8 B | 6/6 | MW-40 |
| | Benzene | 5 | 0.36 B | 1/6 | MW-42 |
| | Chloroform | 100 | 0.22 | 3/6 | MW-42 |
| | Chloromethane | -- | 2.33 B | 6/6 | N-3 |
| | 1,2-Dichloroethane | 5 | 2.2 | 2/6[2] | N-3 |
| | Ethylbenzene | 700 | 0.36 | 2/6 | MW-42 |
| | 2-Hexanone | -- | 1.6 | 2/6 | MW-40 |
| | Methylene chloride | 5 | 1.22 B | 6/6 | N-3 |
| | Toluene | 1000 | 0.63 | 6/6 | MW-42 |
| | m & p-Xylene | -- | 0.35 | 2/6 | MW-42 |
| | o-Xylene | -- | 0.12 B | 1/6 | MW-42 |
| SW8270 (µg/L) | Dimethylphthalate | -- | 8.18 | 2/6 | N-3 |
| | bis(2-Ethylhexyl)phthalate | 6 | 4.45 B | 1/6 | MW-40 |
| SW6010, Total (mg/L) | Barium | 2 | 0.00714 B | 6/6 | MW-42 |
| | Beryllium | 0.004 | 0.00169 B | 4/6 | MW-40 |
| | Manganese | -- | 0.0138 | 5/6 | MW-42 |
| | Zinc | -- | 0.00779 B | 3/6 | N-3 |

[1] Maximum contaminant level (MCL); 40 CFR § 141.61 for Federal MCLs, and 18 AAC 80.070 for State MCLs. Federal and State MCLs are identical for the listed constituents.

[2] Frequency "hits" calculation does not include one or more results removed from the data set because they did not meet QA/QC criteria. Total sample count includes all samples analyzed for the indicated parameter.

B - Sample concentration was less than or equal to the blank UTL.

## Table 7.3-2

## Summary of Surface Soil Analytical Results for Source SD73
## Elmendorf AFB, AK

| Method (units) | Analyte | ACM Guideline [1] | Background Upper Tolerance Limit | Maximum Result | Depth of Maximum Results (ft) | Frequency of Detection Total Hits/ Total Samples | Location of Maximum Result |
|---|---|---|---|---|---|---|---|
| **Indicator Parameters** | | | | | | | |
| SW9045 (pH units) | pH | -- | -- | 6.95 | 1.5 | 1/1 | SS-080 |
| D2216 (percent) | Percent moisture | -- | -- | 32.4 | 3 | 19/19 | A2-SS18 |
| SW8015MP (µg/kg) | Ethylbenzene | -- [2] | -- | 11.3 P | 3 | 1/4 | A2-SS15 |
| | Toluene | -- [2] | -- | 31.3 B | 3 | 4/4 | A2-HA-1-01 |
| | Xylene (total) | -- [2] | -- | 91.1 | 3 | 2/4 | A2-SS17 |
| SW6010 (mg/kg) | Aluminum | -- | 31183.96 | 31000 | 1 | 19/19 | SS-082 |
| | Calcium | -- | 8013.23 | 8320 | 1 | 19/19 | SS-084 |
| | Iron | -- | 43192.35 | 35100 | 1.5 | 19/19 | SS-081 |
| | Magnesium | -- | 10904.10 | 9680 | 2 | 19/19 | MW-40 |
| | Potassium | -- | 845.75 | 1620 | 3 | 19/19 | A2-HA-3-01 |
| | Sodium | -- | 427.05 | 259 | 3 | 19/19 | A2-HA-3-01 |
| **Contaminant Parameters** | | | | | | | |
| SW8240 (µg/kg) | Acetone | -- | -- | 12.6 B | 1.5 | 9/19 | SS-079 |
| | 2-Butanone(MEK) | -- | -- | 44.6 B | 3 | 11/19 | A2-SS17 |
| | Chloroform | -- | -- | 30.1 | 1.5 | 7/19 | SS-081 |
| | Methylene chloride | -- | -- | 31.5 | 3 | 11/19 | A2-HA-3-01 |
| SW8270 (mg/kg) | Acenapthylene | -- | -- | 0.0222 | 3 | 1/19 | A2-SS16 |
| | Anthracene | -- | -- | 0.0719 | 3 | 1/19 | A2-SS16 |
| | Benzo(a)anthracene | -- | -- | 0.216 | 3 | 2/19 | A2-SS16 |
| | Benzo(a)pyrene | -- | -- | 0.327 | 3 | 2/19 | A2-SS16 |
| | Benzo(b)fluoranthene | -- | -- | 0.945 F | 3 | 4/19 | A2-SS16 |
| | Benzo(g,h,i)perylene | -- | -- | 0.0821 | 3 | 1/19 | A2-SS16 |
| | Benzo(k)fluoranthene | -- | -- | 0.945 F | 3 | 3/19 | A2-SS16 |
| | Benzyl alcohol | -- | -- | 0.188 | 1 | 1/19 | SS-083 |
| | bis(2-Ethylhexyl) phthalate | -- | -- | 53.7 | 3 | 6/19 | A2-HA-3-01 |
| | Butylbenzylphthalate | -- | -- | 0.0488 | 3 | 2/19 | A2-SS16 |
| | Chrysene | -- | -- | 0.595 | 3 | 6/19 | A2-SS16 |
| | Dibenz(a,h)anthracene | -- | -- | 0.047 | 3 | 1/19 | A2-SS16 |
| | Di-n-butylphthalate | -- | -- | 0.325 | 3 | 2/19 | A2-SS15 |
| | Di-n-octylphthalate | -- | -- | 0.0784 | 3 | 2/19 | A2-SS15 |
| | Fluoranthene | -- | -- | 0.762 | 1.5 | 4/19 | SS-081 |
| | Indeno(1,2,3-cd)pyrene | -- | -- | 0.102 | 3 | 1/19 | A2-SS16 |
| | 2-Methylnaphthalene | -- | -- | 25.7 | 2 | 4/19 | SB-37 |
| | Naphthalene | -- | -- | 0.33 | 3 | 2/19 | A2-SS17 |
| | 4-Nitroaniline | -- | -- | 0.13 | 3 | 1/19 | A2-SS15 |
| | Pentachlorophenol | -- | -- | 0.245 | 3 | 5/19 | A2-HA-2-01 |
| | Phenanthrene | -- | -- | 1.3 | 2 | 6/19 | SB-37 |
| | Pyrene | -- | -- | 0.508 | 1.5 | 5/19 | SS-081 |

## Table 7.3-2

## (Continued)

| Method (units) | Analyte | ACM Guideline [1] | Background Upper Tolerance Limit | Maximum Result | Depth of Maximum Results (ft) | Frequency of Detection Total Hits/ Total Samples | Location of Maximum Result |
|---|---|---|---|---|---|---|---|
| SW6010 (mg/kg) | Antimony | -- | NA | 280 | 3 | 7/19 | A2-HA-3-01 |
| | Barium | -- | 196.45 | 516 | 3 | 19/19 | A2-HA-3-01 |
| | Beryllium | -- | 0.76 | 0.73 | 2 | 19/19 | MW-43 |
| | Cadmium | -- | 2.68 | 2.34 | 3 | 4/19 | A2-HA-3-01 |
| | Chromium | -- | 48.44 | 40.6 | 3 | 19/19 | A2-HA-1-01 |
| | Cobalt | -- | 19.52 | 14.2 | 2 | 19/19 | MW-43 |
| | Copper | -- | 31.67 | 177 | 3 | 19/19 | A2-SS16 |
| | Manganese | -- | 929.98 | 743 | 2 | 19/19 | MW-43 |
| | Molybdenum | -- | NA | 2.53 | 3 | 15/19 | A2-HA-3-01 |
| | Nickel | -- | 50.68 | 35.2 | 3 | 19/19 | A2-HA-1-01 |
| | Selenium | -- | 0.54 | 16.5 | 2 | 11/19 | SB-37 |
| | Silver | -- | 1.68 | 107 | 3 | 7/19 | A2-HA-3-01 |
| | Vanadium | -- | 101.64 | 87.2 | 1.5 | 19/19 | SS-081 |
| | Zinc | -- | 90.01 | 898 | 3 | 19/19 | A2-SS17 |
| SW7060 (mg/kg) | Arsenic | -- | 13.27 | 26 | 3 | 19/19 | A2-HA-3-01 |
| SW7241 (mg/kg) | Lead | -- | 10.69 | 339 | 3 | 19/19 | A2-SS16 |
| SW7471 (mg/kg) | Mercury | -- | 0.20 | 0.537 | 3 | 17/19 | A2-SS16 |

[1] Alaska Cleanup Matrix (ACM) Level C; 18 AAC 78.315.
[2] The ACM Level C guideline for benzene, toluene, ethylbenzene, and xylenes (BTEX) combined is 50,000 µg/kg.
B - Sample concentration was less than or equal to the blank UTL.
F - Co-elution or interference was suspected.
NA - Not applicable.
P - Analyte quantitation not confirmed. Results from primary and secondary GC columns differ by greater than a factor of three.

## Table 7.3-3

## Summary of Subsurface Soil Analytical Results for Source SD73
## Elmendorf AFB, AK

| Method (units) | Analyte | ACM Guideline [1] | Background Upper Tolerance Limit | Maximum Result | Depth of Maximum Results (ft) | Frequency of Detection Total Hits/ Total Samples | Location of Maximum Result |
|---|---|---|---|---|---|---|---|
| **Indicator Parameters** | | | | | | | |
| SW9045 (pH units) | pH | -- | -- | 7.37 | 14 | 1/1 | MW-40 |
| D2216 (percent) | Percent moisture | -- | -- | 25.3 | 4 | 39/39 | SB-37 |
| SW6010 (mg/kg) | Aluminum | -- | 18116.77 | 22000 | 4 | 21/21 | SB-37 |
| | Calcium | -- | 10264.39 | 9650 | 26 | 21/21 | SB-39 |
| | Iron | -- | 38483.64 | 31000 | 4 | 21/21 | SB-37 |
| | Magnesium | -- | 14784.34 | 12000 | 30 | 21/21 | SB-38 |
| | Potassium | -- | 1114.35 | 1260 | 4 | 21/21 | MW-40 |
| | Sodium | -- | 365.59 | 185 | 10 | 21/21 | SB-38 |
| **Contaminant Parameters** | | | | | | | |
| SW8240 ($\mu$g/kg) | Acetone | -- | -- | 81.3 B | 4 | 14/21 | SB-37 |
| | 2-Butanone(MEK) | -- | -- | 20.9 B | 4.5 | 15/21 | A2-HA-1-02 |
| | Chloroform | -- | -- | 31.7 | 6 | 8/21 | SB-41 |
| | Ethylbenzene | -- [2] | -- | 127 | 4 | 1/21 | SB-37 |
| | Methylene chloride | -- | -- | 12 | 4.5 | 11/21 | A2-HA-1-02 |
| | Toluene | -- [2] | -- | 130 | 4 | 2/21 | SB-37 |
| | Tribromomethane (Bromoform) | -- | -- | 28.1 | 6 | 2/21 | SB-41 |
| | m & p-Xylene | -- [2] | -- | 1320 | 4 | 1/21 | SB-37 |
| | o-Xylene | -- [2] | -- | 994 | 4 | 1/21 | SB-37 |
| SW8270 ($\mu$g/kg) | Benzo(a)pyrene | -- | -- | 0.274 | 4 | 1/21 | MW-40 |
| | Benzo(b)fluoranthene | -- | -- | 0.444 F | 4 | 1/21 | MW-40 |
| | Benzo(k) floranthene | -- | -- | 0.444 F | 4 | 1/21 | MW-40 |
| | Chrysene | -- | -- | 0.228 | 4 | 1/21 | MW-40 |
| | Di-n-butylphthalate | -- | -- | 0.32 | 4.5 | 1/21 | A2-HA-3-02 |
| | bis(2-Ethylhexyl) phthalate | -- | -- | 15.7 | 4.5 | 2/21 | A2-HA-3-02 |
| | Fluoranthene | -- | -- | 0.301 | 4 | 1/21 | MW-40 |
| | 2-Methylnaphthalene | -- | -- | 0.0314 | 26 | 1/21 | SB-39 |
| | Phenanthrene | -- | -- | 0.388 | 4 | 1/21 | SB-37 |
| | Pyrene | -- | -- | 0.271 | 4 | 2/28 | MW-40 |
| SW6010 (mg/kg) | Antimony | -- | NA | 10.9 | 28 | 10/21 | MW-43 |
| | Barium | -- | 95.93 | 125 | 4 | 21/21 | SB-37 |
| | Beryllium | -- | 0.64 | 0.644 | 8 | 21/21 | SB-41 |
| | Chromium | -- | 76.94 | 42.2 | 22 | 21/21 | MW-40 |
| | Cobalt | -- | 17.62 | 11.8 | 12 | 21/21 | SB-39 |
| | Copper | -- | 59.84 | 30.7 | 12 | 21/21 | SB-39 |
| | Manganese | -- | 709.45 | 623 | 10 | 21/21 | SB-43 |
| | Molybdenum | -- | NA | 1.63 | 4 | 17/21 | MW-40 |
| | Nickel | -- | 71.79 | 39 | 12 | 21/21 | SB-39 |
| SW6010 (mg/kg) | Selenium | -- | 0.48 | 18.6 | 30 | 21/21 | SB-38 |
| | Silver | -- | 1.06 | 3.25 | 4.5 | 9/21 | A2-HA-3-02 |
| | Vanadium | -- | 66.16 | 71.9 | 26 | 21/21 | SB-39 |

**Table 7.3-3**

**(Continued)**

| Method (units) | Analyte | ACM Guideline [1] | Background Upper Tolerance Limit | Maximum Result | Depth of Maximum Results (ft) | Frequency of Detection Total Hits/ Total Samples | Location of Maximum Result |
|---|---|---|---|---|---|---|---|
| SW6010 (mg/kg) (continued) | Zinc | -- | 76.17 | 98.7 | 4 | 21/21 | SB-37 |
| SW7060 (mg/kg) | Arsenic | -- | 9.31 | 70.4 | 4.5 | 21/21 | A2-HA-3-02 |
| SW7421 (mg/kg) | Lead | -- | 10.13 | 29.8 | 4 | 21/21 | SB-37 |
| SW7471 (mg/kg) | Mercury | -- | 0.21 | 0.87 | 4 | 14/21 | SB-37 |

[1] Alaska Cleanup Matrix (ACM) Level C; 18 AAC 78.315.
[2] The ACM Level C guideline for benzene, toluene, ethylbenzene, and xylenes (BTEX) combined is 50000 $\mu$g/kg.
B - Sample concentration was less than or equal to the blank UTL.
F - Co-elution or interference was suspected.
NA - Not applicable.

### 7.3.2 Risk Evaluation

Based on the concentrations of contaminants detected during the RI, human health and environmental risk assessments were performed to determine if areas should be considered for remedial action. All concentrations of contaminants, including all contaminants of concern, whether exceeding MCLs or ACM guidelines or not, were included in the risk assessments. The general discussion of the human health and ecological risk assessment procedures is presented in Section 2.3.2, and will not be repeated since the procedures for each of the source areas within OU 6 were identical. Details on the parameters used in the Health Risk Assessment are shown on Table 2.3-5.

**Human Health Risk Assessment (HRA)**

Since SD73 is not currently used residentially, a *current* residential risk scenario was not evaluated and only current visitor and trench worker scenarios were applied. This area may be used residentially in the future; therefore, the *future* residential risk scenario was evaluated at SD73 to obtain the most conservative risk information possible.

ELCRs and HIs were calculated to describe cancer and noncancer risks, respectively. The ELCR is the additional chance that an individual exposed to site contamination will develop cancer during his/her lifetime. It is expressed as a probability such as 1.0E-06 (one in a million). The HI estimates the likelihood that exposure to the contamination will cause some negative health effect. An HI score above one indicates that some people exposed to the contamination may experience at least one negative health effect.

The calculated risks at SD73 are based upon hypothetical exposure to soil and groundwater. The shallow groundwater aquifer at SD73 is not presently used, and will not be used in the future for supplying potable or non-potable water. For carcinogenic soil risk, the calculated results for the future resident (RME), construction worker, and visitor are listed. Only the future resident scenario (RME) was used to calculate carcinogenic groundwater risk. Table 7.3-4 summarizes the calculated carcinogenic and noncarcinogenic human health risks calculated for SD73.

The residential RME cancer risk for groundwater at SD73 exceeds 1.0E-06. This risk is driven exclusively by 1,2-dichloroethane, which was detected at a maximum concentration well below MCLs. Noncarcinogenic risk was not identified in the groundwater. In soils, the residential RME cancer risk exceeded 1.0E-05, and the visitor scenario exceeded 1.0E-06. This risk is driven entirely by arsenic, which occurs at background concentrations. Noncarcinogenic risk for soils was also identified in the RME scenario above 1.0 for arsenic and manganese.

**Ecological Risk Assessment (ERA)**

The ERA was performed to determine if the reported concentrations of chemicals or calculated exposures to plants and wildlife at OU 6 are likely to produce adverse effects. Ecological effects were evaluated quantitatively by calculating Ecological Quotients (EQs). The ERA focused on evaluating potential impacts of the contamination on selected indicator species: the moose, masked shrew, meadow vole, black-capped chickadee, merlin, and peregrine falcon. The general discussion of the ecological risk assessment procedures is presented in Section 2.3.2 and will not be repeated since the procedures for each of the source areas within OU 6 were identical.

Both metals and SVOC concentrations were sufficient in soils at SD73 to cause the EQs for small animals to exceed 1.0. EQs exceeded 1.0 for the black capped chickadee and meadow vole due

## Table 7.3-4

**Summary of Human Health Risks at SD73**
**Elmendorf AFB, AK**

| Risk | Surface Soil (<3 feet) | | Subsurface Soil | Chemical(s) Driving Risk |
|---|---|---|---|---|
| | Residential Scenario[a] | Visitor Scenario[b] | Trench Worker Scenario[c] | |
| **Soil Risk [d]** | | | | |
| Carcinogenic | 2.4E-05 | 1.4E-06 | <1.0E-06 | Arsenic |
| Non-Carcinogenic | 2.7 | 0.13 | NR | Arsenic, Manganese |
| **Groundwater Risk [d]** | | | | |
| Carcinogenic | 9.8E-06 | NA | NA | 1,2-Dichloroethane |
| Non-Carcinogenic | NR | NA | NA | NA |

[a] Excess cancer risks conservatively assumed for 30 years of exposure (drinking groundwater, contact with soil, etc.) by future residents (Reasonable Maximum Exposure).
[b] Excess cancer risks conservatively assumed for 30 years of exposure while visiting the site under current conditions.
[c] Excess cancer risks conservatively assumed for 1 year of exposure during on-site construction work (digging, etc.).
[d] Risks are calculated by using the 95% upper confidence limits (UCLs) for contaminants present unless the 95% UCL exceeded the maximum concentration detected, in which case the maximum concentration was used. This represents a conservative estimate of the "worst case" contamination.
NA - Not applicable.
NR - Significant risk not identified.


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to elevated lead, selenium, and zinc concentrations. Elevated lead also caused the EQ for the masked shrew to exceed 1.0. The highest calculated EQ was for lead for the black capped chickadee (2200), followed by an EQ of 720 for barium, also for the black capped chickadee. In addition, benzo(a)anthracene concentrations caused exceedances for the black capped chickadee, and benzo(a)anthracene and bis(2-ethylhexyl)phthalate caused exceedances for the shrew. EQs were calculated based on surface soil contaminant concentrations. The highest organic EQ was 4.9, for bis(2-ethylhexyl)phthalate in the black capped chickadee. None of the calculated EQs exceeded 1.0 for the moose, peregrine falcon, or merlin at SD73. From an ecological risk point of view, it is not believed that wildlife in this area will be significantly affected since the area is scheduled to be converted into a housing/community development. While EQs did exceed 1.0 for several constituents and indicator species, the risk estimates are considered to be very conservative based on the planned land use for this source area.

**Uncertainties Associated with the Risk Assessment**

The major assumptions and uncertainty factors for the OU 6 human health and ecological risk assessments are presented in Section 2.3.2.

### 7.3.3 Conclusions

The following subsections provide a discussion of the determination of COCs for SD73, the location and extent of contamination by any COCs in excess of preliminary remediation goals, and a summary statement about the risk to public health, welfare, or the environment if action is not taken at SD73.

**Contaminants of Concern**

No constituents exceeding preliminary remediation goals (MCLs for groundwater or ACM guidelines for soils) were identified in the Proposed Plan. COCs for OU 6 were developed from the results of the risk assessment and by considering preliminary remediation goals. Each constituent having an individual contribution of greater than 1.0E-06 carcinogenic (RME) risk, or an HI greater than 0.1 when the cumulative HI for the site is greater than 1.0, was considered as a COC. In addition, any constituent exceeding preliminary remediation goals (MCLs for groundwater or ACM guidelines for soil) was also considered as a COC.

No COCs were identified for SD73 based upon the above criteria. The carcinogenic risk for groundwater was exceeded only by 1,2-dichloroethane. The concentrations of this constituent did not exceed MCLs; therefore, it was not included as a COC. Metals concentrations in the groundwater were below MCLs and were comparable to background concentrations. Arsenic and manganese in the soils were not considered COCs because the concentrations detected were comparable to background levels.

**Summary**

No COCs were identified for Source SD73; therefore, there is no risk of imminent or substantial endangerment to public health, welfare, or the environment at this site. As a consequence, no further response action is required.

## 7.4 Remedial Action Objectives, Alternatives, and Comparative Analysis for SD73

The following subsections discuss the remedial action objectives for SD73, and present a description of the various alternatives which were evaluated to achieve those remedial objectives. The results of the detailed comparison made between those alternatives are also presented.

### 7.4.1 Remedial Action Objectives

Remedial action objectives (RAO) are developed based on COCs, potential exposure routes and receptors, and remediation goals. As discussed in Section 7.3.3, the groundwater and soils in SD73 have no COCs; thus, RAOs were not developed for SD73 groundwater or soils.

### 7.4.2 Groundwater Alternatives

Groundwater alternatives are developed to meet RAOs. As discussed in Sections 7.3.3 and 7.4.1, the groundwater at SD73 does not have any COCs or RAOs; therefore, alternatives were not developed for the SD73 groundwater. Consequently, a comparative analysis of groundwater alternatives was not conducted.

### 7.4.3 Soil Alternatives

Soil alternatives are developed to meet RAOs. As discussed in Sections 7.3.3 and 7.4.1, the soil at SD73 does not have any COCs or RAOs; therefore, alternatives were not developed for the SD73 soils. Consequently, a comparative analysis of soil alternatives was not conducted.

## 7.5 Selected Remedy for SD73

The selected remedy for SD73 is as follows:

**Groundwater at SD73:**

- No further action is required for the groundwater at SD73.

**Soil at SD73:**

- No further action is required for the soil at SD73.

The State of Alaska concurs with the USAF and with the USEPA in the selection of no further action for SD73. Based on comments received during the public comment period, the public has no preference.

### 7.5.1 Statutory Determinations

There are no risks to human health and the environment and no ARARs associated with SD73. No further action is required.

### 7.5.2 Documentation of Significant Changes

The selected remedy was the preferred alternative presented in the Proposed Plan (Table 7 of the Proposed Plan).

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## SECTION EIGHT

## Section 8.0
## REFERENCES


Alaska Department of Environmental Conservation (ADEC). Resource Conservation and Recovery Act (RCRA) Facility Assessment Report: Preliminary Review and Visual Site Inspection. 1988.

Black and Veatch. Installation Restoration Program Stage 3 Remedial Investigation/Feasibility Study Elmendorf Air Force Base, Alaska. 1990.

ENSR. Elmendorf Air Force Base, SERA Phase 1B Site Assessment. 1993.

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Radian Corporation. Environmental Baseline Assessment, NOAA Research Station, Elmendorf AFB, Alaska. 1993a.

Radian Corporation. Limited Field Investigation, Operable Unit 7, Elmendorf AFB, Alaska. 1993b.

U.S. Air Force. Elmendorf Air Force Base, Alaska, Basewide Background Sampling Report. 1993.

U.S. Air Force. Proposed Plan, Operable Unit 6. 1996a.

U.S. Air Force. Remedial Investigation/Feasibility Study Report, Operable Unit 6. 1996b.




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File: OU6
Category #: 5.10
Document Date: 1/27/97

# APPENDIX A

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## Appendix A

### Index to OU 6 Documents in Administrative Record

| Date Submitted | Document Number | Title/Subject | Author |
|---|---|---|---|
| 4/15/94 | 039162-039489 | Management Plan, Operable Unit 6 | USAF-Elmendorf AFB |
| 4/15/94 | 039190-039699 | Management Plan, Operable Unit 6, Appendix A, Field Sampling Plan | USAF-Elmendorf AFB |
| 4/15/94 | 039700-039959 | Management Plan, Operable Unit 6, Appendix B, Quality Assurance Project Plan | USAF-Elmendorf AFB |
| 4/15/94 | 039960-040095 | Management Plan, Operable Unit 6, Appendix C, Site Safety and Health Plan | USAF-Elmendorf AFB |
| 4/15/94 | 040096-040169 | Management Plan, Operable Unit 6, Appendix D, Summary of Historical Analytical Results For OU6 Source Areas and Base Water Supply Wells 50 and 51 | USAF-Elmendorf AFB |
| 4/15/94 | 040170-040173 | Management Plan, Operable Unit 6, Appendix E, Equations Used For Calculation of Risk-Based Concentrations | USAF-Elmendorf AFB |
| 4/15/94 | 040174-040201 | Management Plan, Operable Unit 6, Appendix F, Evaluation of Groundwater Flow and Transport of Contaminants in The Vadose Zone at Source SD15 | USAF-Elmendorf AFB |
| 4/15/94 | 040202-040205 | Management Plan, Operable Unit 6, Appendix G, Plan Acknowledgments | USAF-Elmendorf AFB |
| 6/23/95 | 061107-061167 | No Further Remedial Action Plan, Bunker 64-580 Soil Removal, Appendix E | USAF-Elmendorf AFB |
| 9/28/95 | 054430-054436 | Peer Review Report For Elmendorf Operable Unit 6 Remedial Investigation/Feasibility Study | HQ PACAF/CEVR |
| 11/17/95 | 054484 | Public Notice - The Air Force Announces The Availability of Documents, The Record of Decision For Operable Unit 4 and The Remedial Investigation/ Feasibility Study for Operable Unit 6 | USAF-Elmendorf AFB |
| 11/19/95 | 054486 | Public Notice - The Air Force Announces The Availability of Documents, The Record of Decision For Operable Unit 4 and The Remedial Investigation/ Feasibility Study for Operable Unit 6 | USAF-Elmendorf AFB |

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## Appendix A

## (Continued)

| Date Submitted | Document Number | Title/Subject | Author |
|---|---|---|---|
| 12/11/95 | 060913-060925 | Response to Comments on Draft Final RI/FS Report, Operable Unit 6 | USAF-Elmendorf AFB |
| 12/22/95 | 060926-060929 | Confirmation Notice No. 12, Operable Unit 6, Installation Restoration Program, Remedial Investigation/Feasibility Study - Minutes from 13 December 1995 Meeting to discuss the Preferred Alternatives for OU 6 | USAF-Elmendorf AFB |
| 1/2/96 | 054407-055351 | Remedial Investigation/Feasibility Study Report, Operable Unit 6 | USAF-Elmendorf AFB |
| 1/2/96 | 055352-055541 | Remedial Investigation/Feasibility Study Report, Operable Unit 6, Appendix A - Aquifer (Slug) Test Data | USAF-Elmendorf AFB |
| 1/2/96 | 055542-055615 | Remedial Investigation/Feasibility Study Report, Operable Unit 6, Appendix B - Historical and Other Supporting Data | USAF-Elmendorf AFB |
| 1/2/96 | 055616-056049 | Remedial Investigation/Feasibility Study Report, Operable Unit 6, Appendix C - Background Data - Statistics | USAF-Elmendorf AFB |
| 1/2/96 | 056050-056083 | Remedial Investigation/Feasibility Study Report, Operable Unit 6, Appendix D - Bench-Scale Desorption Testing For OU6 | USAF-Elmendorf AFB |
| 1/2/96 | 056084-056155 | Remedial Investigation/Feasibility Study Report, Operable Unit 6, Appendix E - Geophysical Data | USAF-Elmendorf AFB |
| 1/2/96 | 056156-056301 | Remedial Investigation/Feasibility Study Report, Operable Unit 6, Appendix F - QA/QC Results Summary | USAF-Elmendorf AFB |
| 1/2/96 | 056302-056415 | Remedial Investigation/Feasibility Study Report, Operable Unit 6, Appendix G - Field GC Data | USAF-Elmendorf AFB |
| 1/2/96 | 056416-056448 | Remedial Investigation/Feasibility Study Report, Operable Unit 6, Appendix H - Lead and Chloride Field Screening | USAF-Elmendorf AFB |
| 1/2/96 | 056449-056512 | Remedial Investigation/Feasibility Study Report, Operable Unit 6, Appendix I - Soil Gas Report | USAF-Elmendorf AFB |

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# Appendix A

## (Continued)

| Date Submitted | Document Number | Title/Subject | Author |
|---|---|---|---|
| 1/2/96 | 056513-056685 | Remedial Investigation/Feasibility Study Report, Operable Unit 6, Appendix J - Field Logs (Soil Boring Logs and Groundwater) | USAF-Elmendorf AFB |
| 1/2/96 | 056686-056703 | Remedial Investigation/Feasibility Study Report, Operable Unit 6, Appendix K - Geotechnical Results | USAF-Elmendorf AFB |
| 1/2/96 | 056704-056727 | Remedial Investigation/Feasibility Study Report, Operable Unit 6, Appendix L - Chemistry Appendix | USAF-Elmendorf AFB |
| 1/2/96 | 056728-056772 | Remedial Investigation/Feasibility Study Report, Operable Unit 6, Appendix M - Groundwater Monitoring Well Completion Logs | USAF-Elmendorf AFB |
| 1/2/96 | 056773-056802 | Remedial Investigation/Feasibility Study Report, Operable Unit 6, Appendix N - Survey Data | USAF-Elmendorf AFB |
| 1/2/96 | 056803-056832 | Remedial Investigation/Feasibility Study Report, Operable Unit 6, Appendix O - Waste Management | USAF-Elmendorf AFB |
| 1/2/96 | 056833-057274 | Remedial Investigation/Feasibility Study Report, Operable Unit 6, Appendix P - Risk Assessment Tables | USAF-Elmendorf AFB |
| 1/2/96 | 057275-057778 | Remedial Investigation/Feasibility Study Report, Operable Unit 6, Appendix Q - Field Log Location Forms | USAF-Elmendorf AFB |
| 1/2/96 | 057779-057795 | Remedial Investigation/Feasibility Study Report, Operable Unit 6, Appendix R - Base Water Supply Well Data | USAF-Elmendorf AFB |
| 1/2/96 | 057796-058548 | Remedial Investigation/Feasibility Study Report, Operable Unit 6, Appendix S - Laboratory Data | USAF-Elmendorf AFB |
| 1/2/96 | 058549-058572 | Remedial Investigation/Feasibility Study Report, Operable Unit 6, Appendix T - Conceptual Site Model | USAF-Elmendorf AFB |

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| Date Submitted | Document Number | Title/Subject | Author |
|---|---|---|---|
| 1/2/96 | 058573-058607 | Remedial Investigation/Feasibility Study Report, Operable Unit 6, Appendix U - Fate and Transport | USAF-Elmendorf AFB |
| 1/2/96 | 058608-058629 | Remedial Investigation/Feasibility Study Report, Operable Unit 6, Appendix V - Groundwater Modeling Results For Sources | USAF-Elmendorf AFB |
| 1/2/96 | 058630-058643 | Remedial Investigation/Feasibility Study Report, Operable Unit 6, Appendix W - Additional Data Collected During The OU6 RI | USAF-Elmendorf AFB |
| 1/2/96 | 058644-058651 | Remedial Investigation/Feasibility Study Report, Operable Unit 6, Appendix X - Preliminary Remediation Goals and Contaminants of Concern (COC) | USAF-Elmendorf AFB |
| 1/2/96 | 058652-058701 | Remedial Investigation/Feasibility Study Report, Operable Unit 6, Appendix Y - Identification of Preliminary ARARs | USAF-Elmendorf AFB |
| 1/2/96 | 058702-058853 | Remedial Investigation/Feasibility Study Report, Operable Unit 6, Appendix Z - Calculation Sheets and Other Documentation | USAF-Elmendorf AFB |
| 1/2/96 | 058854-059147 | Remedial Investigation/Feasibility Study Report, Operable Unit 6, Appendix AA - Cost Estimates | USAF-Elmendorf AFB |
| 1/2/96 | 059148-059395 | Remedial Investigation/Feasibility Study Report, Operable Unit 6, Appendix BB - Elmendorf OU6 FS Addendum 1995 Investigation | USAF-Elmendorf AFB |
| 3/6/96 | 061001-061004 | Comments on OU 6 Draft Proposed Plan, February 1996 | USAF-Elmendorf AFB |
| 3/8/96 | 061005-061011 | Comments on Draft Proposed Plan for Operable Unit 6 | USAF-Elmendorf AFB |
| 3/22/96 | 061062 | Public Notice - The Air Force Announces a Public Comment Period and A Public Information Meeting, The Proposed Plan for Final Remedial Action, Operable Unit 6, Elmendorf AFB, AK | USAF-Elmendorf AFB |
| 4/1/96 | 061065 | No Further Action Plan for SS19 | USAF-Elmendorf AFB |

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## Appendix A

**(Continued)**

| Date Submitted | Document Number | Title/Subject | Author |
|---|---|---|---|
| 4/1/96 | 060977-061000 | Elmendorf AFB - OU 6, The Proposed Plan for Remedial Action | USAF-Elmendorf AFB |
| 4/1/96 | 061066-061093 | No Further Action Plan, Bunker 64-580 Soil Removal | USAF-Elmendorf AFB |
| 4/1/96 | 061094-061096 | No Further Action Plan, Bunker 64-580 Soil Removal- Appendix A | USAF-Elmendorf AFB |
| 4/1/96 | 061097-061099 | No Further Action Remedial Action Plan, Bunker 64-580 Soil Removal, Appendix B | USAF-Elmendorf AFB |
| 4/1/96 | 061102-061106 | No Further Action Remedial Action Plan, Bunker 64-580 Soil Removal, Appendix D | USAF-Elmendorf AFB |
| 4/1/96 | 061168-061467 | No Further Action Remedial Action Plan, Bunker 64-580 Soil Removal, Appendix F | USAF-Elmendorf AFB |
| 4/9/96 | 061704-061720 | Public Response for OU 6 Proposed Plan | USAF-Elmendorf AFB |
| 4/10/96 | 061063-061064 | Public Response for OU 6 Proposed Plan | USAF-Elmendorf AFB |
| 4/17/96 | 061614-061662 | Operable Unit 6 Public Meeting, Elmendorf Air Force Base Restoration Advisory Board | USAF-Elmendorf AFB |
| 4/29/96 | 061663-061664 | Public Response for OU 6 Proposed Plan | USAF-Elmendorf AFB |
| 5/1/96 | 061665 | Operable Unit 6, Landfill Site LF02 | USAF-Elmendorf AFB |
| 7/1/96 | -- | LF04 Treatability Study Workplan, Operable Unit 6 | USAF-Elmendorf AFB |
| 7/1/96 | -- | LF04 Treatability Study Workplan, Operable Unit 6, Appendix A - Site Health and Safety Plan | USAF-Elmendorf AFB |
| 7/1/96 | -- | LF04 Treatability Study Workplan, Operable Unit 6, Appendix B - Waste Management Plan | USAF-Elmendorf AFB |
| 9/17/96 | 062026-062039 | LF04 Treatability Study Workplan/Scope of Work, Operable Unit 6 | USAF-Elmendorf AFB |

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## (Continued)

| Date Submitted | Document Number | Title/Subject | Author |
|---|---|---|---|
| 9/17/96 | 062040-062043 | LF04 Treatability Study Workplan/Scope of Work , Operable Unit 6, Appendix A - Site Health and Safety Plan | USAF-Elmendorf AFB |
| 9/17/96 | 062044-062047 | LF04 Treatability Study Workplan/Scope of Work, Operable Unit 6, Appendix B - Waste Management Plan | USAF-Elmendorf AFB |

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# PART III

# RESPONSIVENESS SUMMARY

the sites on base addressed in previous risk assessments were included in this study. Again, no future adverse impacts were predicted. Finally, to ensure the protectiveness of Ship Creek, monthly sampling of the water in Ship Creek is being conducted at eight locations along the base boundary. These samples are analyzed for the constituents detected in those sites on base upgradient of Ship Creek. To date, no adverse impacts of the water in Ship Creek have been detected.

**Public Comment 3:** One written comment indicated "Looks like good choices of the various action proposals."

**USAF Response:** No response required.

**Public Comment 4:** Information was submitted on the Seal of the Treasury of North America.

**USAF Response:** This information was not found to be relevant to the proposed remediation at OU 6.

**Response to Oral Public Comments:**

**Public Comment 1:** Could you tell us what the air sparging is?

**USAF Response:** Air sparging is covered under Alternative 6. Air sparging involves blowing air, though a pipe, down a well and discharging it below the groundwater table. This accomplishes two functions. First, it strips contaminants out of the groundwater and releases them to the air. Second, it adds dissolved oxygen to the groundwater which enhances the biodegradation of the contaminants in the groundwater.

**Public Comment 2:** What is the energy consumption of the bioventing system at WP14 and of the high-vacuum extraction system at SD15?

**USAF Response:** That information was not readily available at the Public Meeting, however, the information was subsequently gathered as is presented below:

Bioventing at WP14: 1,700 kw-hrs per month

High-vacuum Extraction at SD15: 30,800 kw-hrs per month

**Public Comment 3:** The slides gave a good definition of all the alternatives and which ones were the preferred alternatives, but there was nothing that gave a definition of the specific problems at each site.

**USAF Response:** That information was presented at the last RAB meeting and was summarized in the meeting minutes. The information is also available from a number of sources. It can be found in the Proposed Plan and in the Remedial Investigation report, both of which are located in the information repositories.

## PART III. RESPONSIVENESS SUMMARY

### Public Input into the OU 6 Selected Remedy

The primary avenues of public input have been through the Proposed Plan and public comment period. The Proposed Plan for OU 6 was issued to the public on 1 April 1996. This began a public comment period that ended on 3 May 1996. To encourage public comment, the USAF inserted a pre-addressed, written comment form in distributed copies of the Proposed Plan. The comment forms were also distributed at the 17 April 1996 public meeting, held at the Regal Alaskan Hotel in Anchorage, Alaska.

The public meeting to receive comments on the Proposed Plan was attended by approximately 30 people, including 16 representatives from the Restoration Advisory Board (RAB). Oral comments were received from three members of the public. Prior to the conclusion of the public comment period, four written comments were received.

All comments received are documented in the administrative record file for the site. A transcript of the public meeting is available for public review at the site information repositories. The repositories are located at the Bureau of Land Management's Alaska Resources Library and the University of Alaska at Anchorage's Consortium Library. Public comments, relevant to OU 6 and/or the environmental restoration program at Elmendorf, are presented below and have been paraphrased for greater clarity. This ROD is based on the documents in the Administrative Record and comments received from the public.

### Response to Written Public Comment:

**Public Comment 1:** The Department of Environmental Conservation from the State of Alaska had a comment on Landfill Site LF02.

The Remedial Investigation had indicated that while there was lead contamination in excess of 6000 mg/kg, it was present predominantly in soils greater than two feet deep. With this assumption, the Air Force, EPA, and ADEC decided that the soil and vegetative cap in existence on the site was sufficient to isolate this lead contamination from any receptors of concern. ADEC has since received data (from a University of Washington study) indicating that there is lead contaminated in soil in excess of 1000 mg/kg in soil less than two feet deep.

ADEC no longer considers the present cover sufficient to meet the final cover requirements of 18 AAC 60. Since this shallow soil contamination seems to be confined to discrete areas, an additional cover will need to be placed only where lead levels in excess of 500 mg/kg are present in the top two feet of soil.

**USAF Response:** Three limited soil covers were included in the selected alternative for LF02 soils. Surface soil areas with lead contamination greater than 500 mg/kg will be covered with 2 feet of soil. These covers are needed to prevent exposure to lead pursuant to CERCLA, but they will also comply with 18 AAC 60.390.

**Public Comment 2:** The following comment was received from the Anchorage Waterways Council.

The Anchorage Waterways Council (AWC) is happy to learn of the Air Force's efforts to clean up Site LF02, but due to its proximity to Ship Creek, the AWC believes that a more aggressive cleanup regimen is warranted.

Both shallow and deep soils at LF02 are significantly contaminated with fuels and/or their decomposition products. Moreover, area groundwater concentrations of several organic solvents are high enough to require cleanup due to increased cancer risks. As far as we know now, this groundwater is not being used as a source of human drinking water, but AWC does not agree that "no significant cumulative impacts" to Ship Creek exist. This landfill and its leachate plume represent a threat to the biota of the Ship Creek ecosystem and, through concentrating organisms (fish), to people at present and in the future. Until these contaminated soils are excavated and removed for treatment, groundwater contamination cannot be expected to decline.

A number of different agencies and groups are investing heavily in the Ship Creek riparian corridor. Past adverse effects on the Creek, both industrial and military, have been acknowledged, studied and scheduled for mitigation. Municipal planners intend to include the corridor in the city-wide bike trail system. Much money, human energy and creativity are being spent to make Ship Creek once again a healthy stream and a community asset. Any significant source of carcinogenic groundwater pollutants, such as those at LF02, work against these efforts.

**USAF Response:** Groundwater modeling was conducted for LF02 in the Remedial Investigation/Feasibility Study (USAF, 1996). This modeling indicated that volatile organic contaminants in the groundwater will not migrate to Ship Creek in concentrations that will adversely affect human health or the ecosystem. The selected alternative for LF02 groundwater includes biannual monitoring of the groundwater. This monitoring will indicate if contaminant concentrations change. Groundwater data will be reviewed annually to ensure that Ship Creek is protected through the sampling of wells between LF02 and Ship Creek. Provisions are built into this Record of Decision to take more aggressive action at LF02 if Ship Creek is threatened.

The Air Force has also undertaken considerable other precautions to ensure that contamination detected on the base does not adversely impact Ship Creek. To accurately depict the groundwater contaminant modeling conducted for sites upgradient of Ship Creek, an extensive study of the creek was conducted to determine how groundwater interacts with the water in the creek, and how that relationship changes with the varying water levels encountered in Ship Creek throughout the year. Another study was conducted to determine what impacts, if any, have resulted from contamination to date on benthic organisms in Ship Creek. This study included sampling of the sediments and organism tissues in Ship Creek. No adverse impacts were detected. A third study was undertaken to calculate the potential future cumulative risk to organisms in Ship Creek. All of